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Seasonal Occurrence of the Fungus *Hirsutella nodulosa* Petch and Granulosis Virus of Sugarcane Internode Borer *Chilo sacchariphagus Indicus* (Kapur)

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Abstract: Seasonal occurrence of the fungus *Hirsutella nodulosa* Petch and granulosis virus (GV) of sugarcane internode borer *Chilo sacchariphagus indicus* (Kapur) (Lepidoptera: Crambidae) was monitored for two years at Coimbatore, Tamil Nadu. *H. nodulosa* was active almost throughout the year except during summer months (April–June). The monthly infection rates varied from 0.0 to 11.0 per cent in both 1993 and 1994, the peak activity being in September. GV was prevalent throughout the year in both study years with higher activity during summer. The levels of infection were 1.0–15.5 and 4.5–17.5 per cent in 1993 and 1994, respectively. *H. nodulosa* activity was negatively correlated with minimum temperature and positively correlated with rainfall in different years. Forenoon R.H. showed a delayed positive effect on the activity of fungus. Activity of GV was not significantly related to any of the weather parameters. In selected sugar factory areas in the State, the rates of *H. nodulosa* infection were lower and the levels of GV infection were higher than those at Coimbatore during harvest period. GV and *H. nodulosa* constitute a potential combination for the control of internode borer.

Keywords: Seasonal occurrence, *Hirsutella nodulosa*, granulosis virus, sugarcane internode borer, *Chilo sacchariphagus indicus*

INTRODUCTION

The internode borer *Chilo sacchariphagus indicus* (Kapur) (Lepidoptera: Crambidae), inflicts serious quantitative and qualitative losses in sugarcane in tropical India (David, 1986). It harbours many parasitoids (David and Easwaramoorthy, 1986) and pathogens (Easwaramoorthy, 1986) which exhibit wide range of intensity and geographical distribution. Amongst the pathogens, the bacterium *Serratia marcescens* Bizio noticed in field collected larvae (Sithanantham, 1979) appeared to be a weak pathogen in laboratory tests (Easwaramoorthy and Santhalakshmi, 1984). However the granulosis virus (GV) Mehta and David, 1980) was widely prevalent in the sugarcane tract of Tamil Nadu State (Easwaramoorthy and Jayaraj, 1987). While fungal pathogens like *Aspergillus flavus* (David, 1964), *Isaria* sp. (David and Kal a, 1965) and *Fusarium subglutinans* (Easwaramoorthy and Santhalakshmi, 1989) were sporadic in the State, another fungus *Hirsutella nodulosa* Petch, recorded in India first by us at Coimbatore on this

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borer (S. Easwaramoorthy *et al.* communicated), has become more regular in recent years. Although the seasonal variations of GV were studied earlier (Easwaramoorthy, 1984), much less is known about *H. nodulosa*. In this paper, we present the data collected on the natural infection rates of *H. nodulosa* and GV in internode borer at Coimbatore and selected sugar factory areas of Tamil Nadu.

MATERIALS AND METHODS

The activity of *H. nodulosa* and GV was monitored for two complete years, *i.e.*, 1993 and 1994 by collecting internode borer larvae (n=100=1400 month^{-1}) from farmer's fields in and around Coimbatore. Larval samples collected discontinuously from September 1991 to December 1992 were also examined for the presence of the fungus. The larvae collected from the field were reared on shoot bits of sugarcane in the laboratory (Easwaramoorthy and Jayaraj, 1987) and examined for disease symptoms. Larvae showing milky white coloration on the ventral side characteristic of GV attack were surface sterilised and collected in sterile water for further studies. Dead larvae that became stiff due to apparen ungal infection were surface sterilised and incubated on moist filter paper for confirn tion. Monthly infection rates were calculated from the number of larvae infected and e larvae collected.

The incidence of *H. nodulosa* and GV was also assessed in selected sugar factory areas (Table 1) in the State. Larvae of internode borer collected from these areas during the harvest period of 1992–93 and 1993–94 crop seasons were brought to the laboratory and maintained on sugarcane shoot bits and examined for disease symptoms.

The infection rates of *H. nodulosa* and GV at Coimbatore were correlated with mean monthly weather parameters, viz. maximum and minimum temperatures, forenoon and afternoon relative humidities (R.H.) and total rainfall. Simple and multiple correlations were worked out for individual years as well as the pooled data for all years. Rates of infection by *H. nodulosa* and GV were correlated with the activity of the parasitoid *Cotesla flavipes* Cameron (Hymenoptera: Braconidae) (J. Srikanth *et al.* communicated) to determine their inter-dependence.

RESULTS AND DISCUSSION

The fungus *H. nodulosa* and GV were the only pathogens noticed on internode borer in the present study. At Coimbatore, *H. nodulosa* was active almost throughout the year (Fig. 1) reaching high levels of infection seasonally. In all study years, the fungus was active during August–April, more or less coinciding with humid months when the fungus reached its peak levels. The fungus showed reduced levels of activity during summer months *i.e.*, April–June. The infection rates varied from 0.1 to 8.0 per cent during September 1991–October 1992, 0.0 to 11.0 per cent in both 1993 and 1994, suggesting a small year-to-year increase. Similar activity pattern (0.3–11.4 per cent) of the fungus was observed during 1990–91 when it was highly active during September–November (S. Easwaramoorthy *et al.* communicated). However, fungal pathogens like *A. flavus* (David and Kalra, 1965) and *F. subglutinans* (Easwaramoorthy and Santhalakshmi, 1989) are known to cause low levels (< 5 per cent) of mortality of internode borer. The fungus was prevalent in four out of the six factory areas surveyed in 1992–93 and

Table 1
Natural occurrence of granulosis virus (GV) and fungus *Hirsutella nodulosa* of internode borer in sugar mill areas of Tamil Nadu

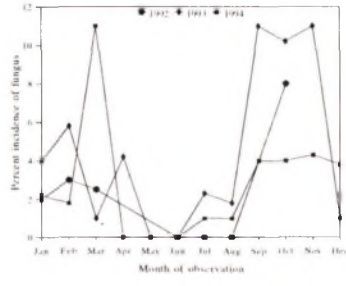
Name and location of sugar mill	1992–93*			1993–94**		
	No. of larvae examined	% incidence		No. of larvae examined	% incidence	
		GV	*H. nodulosa*		GV	*H. nodulosa*
Arignar Anna Sugar Mills, Kurungulam	1937	11.2	0.2	721	11.0	0.0
Perambalur Co-op. Sugar Mills, Eraiyr	461	8.9	1.7	359	15.0	0.3
Kothari Sugars, Kattur	97	27.8	0.0	–	–	–
Thiru Arooran Sugars, Vadapathimangalam	460	14.8	0.2	757	25.2	0.0
Salem Co-op. Sugar Mills, Mohanur	514	7.0	1.2	108	11.1	2.8
Cauvery Sugars, Pettavaithalai	110	7.3	0.0	–	–	–
Vellore Co-op. Sugar Mills, Vellore	–	–	–	256	45.3	0.0

*Larvae collected during December 1992–April 1993
*Larve collected during January–June 1994.

two out of the five factory areas surveyed in 1993–94 (Table. 1). The levels of incidence in both years were lower than those noticed at Coimbatore in the corresponding period and varied between the years.

GV was active throughout the year in both study years at Coimbatore, the levels of infection being 1.0–15.5 per cent in 1993 and 4.5–17.5 per cent in 1994 (Fig. 2). In both years, peak activity of the virus occurred during summer months, *i.e.*, January–May. Whereas the virus remained less active from June to December in 1993, it continued to increase from June in 1994, even reaching a second peak in October. Far higher levels of GV incidence were noticed in the borer (Mehta and David, 1980; Easwaramoorthy, 1984), suggesting a possible decline in its activity in the past decade at Coimbatore. The virus was observed in all the factories surveyed during the two years with a year-to-year variation in intensities (Table 1) which were generally much higher than those noticed at Coimbatore in the corresponding period in both years. In an earlier study, lower mortality rates of internode borer due to GV were recorded in 11 factory areas during 1981–82 crop season (Easwaramoorthy and Jayaraj, 1987). These differences could be due to the variation in the period of sampling and need not necessarily reflect the changes in the activity of the pathogen in the past decade.

The monthly rates of infection of *Hirsutella nodulosa* were negatively correlated ($r = -0.760$, $p<0.01$) with minimum temperature in 1991 and positively correlated ($r = 0.577, p < 0.05$) with rainfall in 1993. The rates of fungal infection in the current



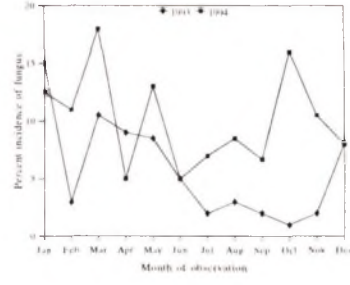


Fig. 1 Fig. 2

Fig. 1. Seasonal fluctuations of the fungs *Hirsutella nodulosa* in sugarcane internode borer of Coimbatore. Fig. 2. Seasonal fluctuations of granulosis virus in sugarcane internode borer at Coimbatore.

month were positive correlated ($r = 0.739, p < 0.01$) with forenoon R. H. in the previous month in 1991 indicating a delayed effect of R. H. on the fungus. However, none of the correlations were consistent in all the years. GV infection rates were not significantly correlated with weather factors in the present study, however, in an earlier study, they were significantly affected by maximum temperature, total sunshine hours, afternoon R. H. and total rainfall (Easwaramoorthy, 1984) indicating periodic variations in the pattern of activity of the virus. On the other hand, the infection rates of GV were significantly enhanced ($r = 0.721$, $p < 0.01$) by the activity of the parasitoid *C. flavipes* in 1994 suggesting its' possible transmission by the latter which, however, needs confirmation.

Attempts to establish the pathogenicity of *H. nodulosa* to internode borer in our studies and for strawberry mite (Alford, 1979) and spruce bud worm (D. M. Strongman, pers. comm.) elsewhere have not been successful. Similarly, information is lacking on its' natural infection rates in two lepidopterous (Petch, 1926; Strongman *et al.* 1990) and three mite (Alford, 1979; Cabrera and Dominguez, 1987; Strongman and Rand, 1991) species recorded as hosts hitherto. However, it does not seem to be a weak pathogen as was indicated by its regularity of occurrence in the present study. In contrast, GV was more abundant, both in the present and earlier studies (Easwaramoorthy, 1984). Life-table studies indicated the positive role of GV as a mortality factor of the borer (Easwaramoorthy and Nandagopal, 1986). Regularity of occurrence, a slight enhanced activity during summer and standardized culturing techniques (Easwaramoorthy, 1984) seem to give GV an edge over *H. nodulosa* was a potential biocontrol agent. The two pathogens together accounted for a monthly mortality of 4.5–19.5 and 4.5–28.5 per cent in 1993 and 1994, respectively, in the borer at Coimbatore. That the two pathogens can occur together was indicated by the absence of a significant negative correlation between them. *H. nodulosa* could probably be used in conjunction with GV to enhance the natural mortality caused by them. While the predominance of *H. nodulosa* in humid months will enable its use in these months, GV may be used in a less restricted manner for the control of the borer.

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The Effect Of Four Botanicals On The Oviposition And Adult Emergence Of *Callosobruchus Maculatus* F. (Bruchidae: Coleoptera)

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Abstract: A Laboratory trial was designed to find the potential of four plants *Piper nigrum* L., *Annona reticulata* L. *Dillenia retusa* L. *Ocimum sanctum* L. transformed into a powder using local technology as protectants against the cowpea bruchid *Callosobruchus maculatus* Fabr. (Bruchidae: Coleoptera) a serious insect pest of stored grain legumes in Sri Lanka. At low concentration, the powder obtained from fruits of *P. nigrum* significantly reduced oviposition and adult emergence while 100% adult mortality was obtained at a higher concentration of 42%. The powder however did not show any fumigant effect. Volatile oils obtained from the same fruits of *P. nigrum* at 0.2 and 0.4% concentrations significantly caused adult mortality while oviposition was completely suppressed at 0.8% and above. The other plants tested did not significantly affected oviposition and adult emergence of *C. maculatus*.

Keywords: *Piper nigrum*, botanicals, *Callosobruchus maculatus*

INTRODUCTION

The effectiveness of vegetable oils in controlling insect pest infestations in grain legumes has been effectively demonstrated by several researches in Asia (Mummigatti and Ragunathan 1977, Varma and Pandey 1978). The oils extracted from the kernels of mee plant *Madhuca longifolia* L. is found significantly lowering the oviposition and egg hatchability of *Callosobruchus maculatus* Fabr. in Sri Lanka (Ranasinghe and Dharmasena 1987). Substantial work has been carried out on the effect of neem products against pulse beetle *Callosobruchus* spp in India (Jotwani and Sircar 1967, Jilani and Mohammed 1975). Sangappa (1977) reported that neem oil applied at 0.75 to 1 (% by weight) protected redgram seeds for 161 days from *C. chinensis* infestation.

Therefore a series of experiments were conducted at the University of Ruhuna, Mapalana, Kamburupitiya, Sri Lanka to explore the possibility of using available botanicals when converted into a powder form against bruchids through local technology. In this study, we report on laboratory evaluation of treatment with powder and volatile oil of *P. nigrum* fruits and powders obtained from leaves of *Annona reticulata* L., *Dillenia retusa* L. and *Ocimum sanctum* L. against *C. maculatus*.

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MATERIALS AND METHODS

C. maculatus culture

A culture of *C. maculatus* was established at 25–30°C and RH 70–80% in the laboratory by introducing 500 unsexed adults into a breeding cage containing mungbean seeds. After 2 weeks all the adults dead or alive found were removed. By this time eggs has been laid by females on most of the seeds. The seeds were divided into smaller lots. Freshly emerged adults obtained from these lots were used for the bioassay.

Preparation of Plant Materials

Freshly picked ripe fruits of *P. nigrum* were obtained from surrounding fields of the university farm at Mapalana, Kamburupitiya. The fruits were air dried under shade to constant weight before being grounded and sieved at the lab with the aid of Raymonds Hammer Mill. The powder obtained with *P. nigrum* fruits were divided into 2 portions. One portion was used for bioassay and the other portion was extracted for its volatile oil. The other plant materials tested in the study *Annona reticulata, Dillenia retusa* and *Ocimum sanctum* leaves were dried in a hot air drier at 5–60°C and powdered to 60 mesh.

The powdered material of *P. nigrum* fruits were placed in one litre round bottom flask and 500 ml of distilled water was added and soaked overnight. Few pieces of earthenware was also added to this flask. The flask was then fitted to volatile oil extraction apparatus for oil extraction. The mixture was gently heated for 4 hrs, until the oil has been completely separated. Distillation was continued to a constant volume of the volatile oil. A yield of about 1.5 ml of oil was obtained. The oil was yellow in colour with an aromatic smell. The oil was then dehydrated and stored in the refrigerator.

Bioassay with powdered *P. nigrum* fruits

Effect of powder on oviposition and adult emergence of *C. maculatus*. To 50 seeds of mungbean variety MI 3 in 50 ml conical flasks was added different weights 1, 2, 4 and 8 g of *P. nigrum* powder. These gave concentrations of 5.3, 10.5, 21.0 and 42.0% respectively calculated by this formulae.

$$\text{Concentration} = \frac{\text{weight of powder} \times 100}{\text{weight of powder} + \text{weight of mungbean}}$$

The control treatment did not have *P. nigrum* powder. Newly emerged *C. maculatus* (5 pairs) were added to each flask. Each flask was plugged with cotton wool and placed inside an incubator (25–31°C and 70–80% RH). Each treatment was replicated 5 times. Egg counts were made at 10 days after treatment (DAT) and 60 DAT. All the adults were removed at this time whether dead or alive. At 30 DAT, seeds were dissected.

Effect of three plant materials on adult mortality

Fifty seeds of mungbean MI 3 obtained from Regional Research Station at Angunakolapelessa were treated with required quantities of each powder to give doses of 0.10, 0.20, and 0.40 g/50 seeds. The treatments were replicated 3 times and kept in 170 ml bottles. Each control had 3 replicates with a separate control treatment with sand. Five pairs of *C. maculatus* were placed in each replicate and covered with muslin cloth. Observations on the adult mortality were recorded periodically for 7 days after which adults were discarded.

Table 1
Oviposition and adult emergence of *Callosobruchus maculatus* on mungbean treated with powder of *Piper nigrum*

Concentration of P. nigrum w/w%	Eggs*		Adult emergence*	
	10DAT	60DAT	10DAT	60DAT
5.3	4.3b	4. 9b	5.1b	5.3b
10.5	3.1b	3. 7b	4.9b	4.7a
21.0	3.9b	3. 9b	2.1b	2.6b
42.0	0.0c	0. 0c	0.0c	0.0c
Control	72.3a	18.63a	54.1a	230.2a

*Means followed by same letter are not significantly different at 5% level by Duncans Multiple Range Test.

Bioassay with volatile oil of *P. nigrum*

Different volumes 0.02, 0.06, 0.2, 0.4, 0.8 of volatile oil obtained by oil extraction apparatus were made upto 400 L with acetone in a covered flask and shaken vigorously after mungbean seeds were introduced. This solution was used to coat uniformly 50 seeds of mungbean tested. After 15 mins when the acetone had dried up the seeds were transferred into 50 ml flask with cover and 5 pairs of *C. maculatus* were introduced. The control treatment has ordinary acetone. The experiment were replicated thrice and the flasks were kept inside the incubator. AT 40 DAT data was taken on number of adults and eggs.

RESULTS

Bioassay with *P. nigrum* fruits powder

Powder of P. nigrum fruits significantly reduced oviposition and adult emergence of *C. maculatus* (Table 1). At 10 DAT no egg was laid on seeds treated at 42%, while only a average of 4.3 eggs were laid on same amount of seeds at 5.3%. However at 60 DAT the control had a mean of 18.6 eggs. No adult emergence were observed in the seeds treated at 42% concentration while upto 54 and 230 adults were obtained in the control at 10 and 60 DAT.

Effect of 3 plant materials on adult mortality

The leaves of *A. reticulata*, and *O. sanctum* gave 40 and 46.0% mortality respectively at 0.10 g/50 seeds but the percentage mortality was low at the other two concentrations tested (Table 2). The powder of *D. retusa* gave 46% adults mortality at 0.10 and 0.20 g/50 seeds concentrations tested.

Bioassay with volatile oil of *P. nigrum*

The volatile oil completely suppressed oviposition of C. maculatus at 0.8% (Table 3). Higher concentrations gave similar effect as no eggs were laid on seeds treated with 0.2% concentrations. Similarly no adults emerged at 0.2% concentrations. However at lower concentrations 37.0 and 19.5 adults emerged at 0.02 and 0.06% concentrations.

Table 2
Effect of three botanicals on adult mortality of
Callosobruchus maculatus

Name of the plant and its taxonomic family	Part of the plant used	Concentration g/50 seeds	% adult mortality at 7 days/a		
			Treated with botanical	Treated with fine sand	Control
Annona reticulata (L.) Annonaceae	Leaf	0.10 0.20 0.40	40.0b 24.6c 26.6c	30	40
Dillenia retusa (l.) Dilleniaceae	Leaf	0.10 0.20 0.40	46.6a 46.6a 33.3c	20	30
Ocinum sanctun (L.) Labiateae	Leaf	0.10 0.20 0.40	40.0b 26.0c 30.0c	20	20

/a Means followed by same letter in each column are not significantly different in DMRT.

Table 3
Performance of *Callosobruchus maculatus* on mungbean treated with varying concentrations of volatile oil of *Piper nigrum* at 40 days after treatment

P. nigrum concentration(%)	Mean number of eggs *±SD	Mean* number of adult emergence ± SD
0.02	58.7±12.2b	37.0±4.2b
0.06	37.6±6.8b	19.5±3.1b
0. 2	0±0c	0±0c
0. 4	0±0c	0±0c
0. 8	0±0c	0±0c
Control	87.1±11.5a	59.6±6.9a

* Means followed by same letter are not significantly different at 5% level by DMRT.

DISCUSSION

The results of this study clearly showed that powder and volatile oil of *P. nigrum* protected mungbean seeds from attack by *C. maculatus*. The volatile oil of *P. nigrum* completely suppressed oviposition and adult emergence at 0.8% concentration. It could be suggested that the volatile oil probably contained a more effective component which is toxic to adults or the component appeared in pure form and acted synergistically in volatile oil in suppressing oviposition. Since both oil and powder of *P. nigrum* is effective in suppressing oviposition and adult emergence both could be recommended for effective control of *C. maculatus*. The processing of *P. nigrum* into a powder using local technology can be easily done at household level in Asia. There is no doubt that *P. nigrum* will be readily accepted as a biocide to preserve mungbean and cowpea from *C. maculatus* attack. Unlike other candidate oils as example neem oil which has an unacceptable flavour to the seeds meant for consumption, *P. nigrum* oil could be readily accepted by farmers. Morallo-Rejesus *et al.* (1989) also reported that ground *P. nigrum* toxic to *C. chinensis*. Grainage and Ahmed (1987) have made a detailed study of plants having pest control properties and has reported 48 plant species that have been found toxic to *C. chinensis* and *P. nigrum* is one of them.

The other plants studied *O. sanctum, D. retusa*, and *A. reticulata* did not significantly caused mortality of *C. maculatus*. However both powder and volatile oils of *P. nigrum* were found to be very effective in suppressing oviposition and adult emergence of *C. maculatus*. The potential of using this plant in storage facilities needs to be evaluated. The possibility of using other biotechnological methods to control *C. maculatus* should also be explored.

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Insect Growth Regulator: Its Impact On Some Predatory Arthropods of Mosquito Immatures

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Abstract: Impact of an insect growth regulator (IGR), hexaflumuron, was studied against *Anisops bouvieri* and *Diplonicus rusticus*, potential biological control agents which prey upon mosquito immatures. These predatory insects were not susceptible to hexaflumuron at concentrations ranging from 0.0001–1.0 mg/l. The predatory efficiency of these insects was not significantly altered at sublethal concentrations of this IGR. Survival of other beneficial arthropod, *Ranatra* sp., dragon fly naiads and a cyclopoid copepod, *Mesocyclops leukarti* at 1.0 mg/l also indicated the safety and utility of hexaflumuron in integrated vector management (IVM).

Keywords: Hexaflumuron, biocontrol agents, mosquito immatures

INTRODUCTION

Predation of mosquitoes by arthropods has been considered to be an important component in integrated control of mosquito population (Collins and Washino, 1985). *Anisops bouvieri*, notonectid bug and *Diplonicus rusticus*, belostomatid bug, are effective arthropod predators commonly found in aquatic habitats and suppress mosquito breeding in nature (Hinman, 1934; Panicker and Rajagopalan, 1977). *Mesocyclops leukarti*, a cyclopoid copepod, also plays useful role in controlling mosquito population by feeding on mosquito larvae especially *Culex, Aedes* and *Anopheles* Species (Revie'ra and Thirel, 1981; Revie'ra *et al.* 1987; Marten *et al.* 1989). Any disturbance in the prey-predator interaction will lead to disruption of the natural regulation of insect population. With the increase in the use of chemicals in aquatic environment both for public health and agriculture purposes, safety of the beneficial nontarget organisms becomes a matter of great concern (Retnakaran *et al.* 1985).

The control potential of insect growth regulators (IGRs), in the field of Integrated Pest Management is becoming more popular (Graham-Bryce, 1987). However, its impact on these biocontrol agent prevailing in fresh water habitats is not fully understood. Therefore, in the present study the impact of hexaflumuron, an insect growth regulator, on predators such as *Anisops bouvieri* and *Diplonicus rusticus* and their predatory efficiency was studied.

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MATERIALS AND METHODS

The predatory insects *Anisops bouvieri* (Hemiptera: Notonectidae), and *Diplonicus rusticus* (Heteroptera: Belostomatidae) were collected from the paddy fields of Kirumambakkam village in Pondicherry. The insects were acclimatized to the laboratory conditions for about 24 hr before treatment. Ten adult notonectids and five belostomatid bugs were exposed to various concentrations (0.0001, 0.0004, 0.0006, 0.001, 0.003, 0.01, 0.1 and 1.0 mg/l) of IGR. Four replicates and appropriate control were maintained at 28 ± 2°C and 70–80% RH. Mortality counts were taken after 24 hr.

To assess the impact of hexaflumuron on the predatory efficiency of these insects, predator and prey were exposed to IGR treatment at 1:100 ratio in 500 ml beakers. Hundred fourth instar larvae of *Cx. quinquefasciatus, Ae. aegypti* and *An. stephensi* were taken as prey and exposed to their respective EI_{50} doses (that inhibit 50% emergence) of 0.0004, 0.00062 and 0.0034 mg/l of hexaflumuron (Vasuki, 1992) along with a predator. Four replicates were maintained and observations made on the number of larvae consumed/killed by the predator every hour for 24 hours. Control with prey and predator but without IGR treatment were also maintained. Larval food was provided to the larvae to prevent mortality due to starvation. Percentage predation in the treated was statistically analysed by ANOVA (Sokal and Rohlf, 1971). Effect of this IGR was also studied against other beneficial aquatic arthropods such as *Ranatra* sp., dragon fly naiads and a cyclopoid copepod, *M. leukarti* at 0.0001–1.0 mg/l.

RESULTS AND DISCUSSION

Hexaflumuron did not show any lethal effect on the predator insects, *A. bouvieri* and *D. rusticus* as no mortality was observed in any of the test concentrations ranging from 0.0001–1.0 mg/l. Each notonectid consumed an average of 39.75%, 56.25% and 47.25% fourth instar larve of *Cx, quinquefasciatus, Ae. aegypti* and *An. stephensi* respectively at sublethal dosages in 24 hrs (Fig. 1). Within 15 hr duration a belostomatid bug could consume 88.25%, 97.5% and 98.5% fourth instar larvae of the above mentioned species respectively at sublethal dosages (Fig. 2). There was no significant ($P>0.05$) difference between the number of fourth instar larvae of the three species consumed by a notonectid/belostomatid bug during treatment and those of the untreated control. Earlier study also showed no adverse effect on notonectid, *Notonects unifasciata* Guerin when the SR–10 formulation of Altosid was applied (Miura and Takahashi, 1974a).

Other beneficial arthropods, *Ranatra* sp. and dragonfly naiads were not killed at the rate of 1.0 mg/l. In an earlier study, fenoxycarb, an IGR, did not exhibit any adverse effect on dragon fly naiads at the mosquito larvicidal rate of 0.11b ai/Acre (Mulla *et al.* 1985; 1986). No apparent harmful effects on dragon fly naiads were noticed in ponds treated with Altosid briquettes (Mulla *et al.* 1988).

The survival of *M. leukarti* at 1.0 mg/l of hexaflumuron also indicated the safety of using this IGR in fresh water breeding habitats. In similar studies, *Cyclops* sp. showed certain degree of tolerance to diflubenzuron (Miura and Takahashi, 1974b). Methoprene was also found to have apparently no effect on the mixed stages of cyclopoid copepod by Miura and Takahashi (1973). In contrast, considerable mortality in early stages of *Apocyclops* sp. at dosages of methoprene ranging from 0.01–10 ppm has been reported (Bircher and Ruber, 1988).

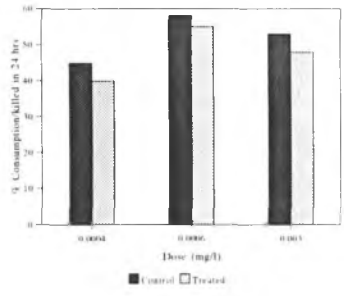

Fig. 1

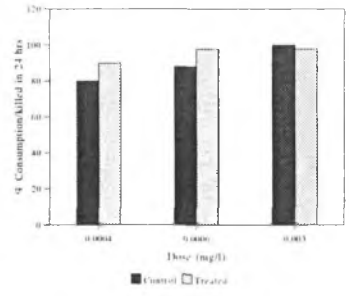

Fig. 2

Fig. 1. Effect of hexaflumuron on predatory efficiency of *D. rusticus* at sublethal concentrations of *Cx. quinquefasciatus* (0.0004 mg/l), *Ae. aegypti* (0.0006 mg/l) and *An. stephensi* (0.003 mg/l).
Fig. 2. Effect of hexaflumuron on predatory efficiency of *A. bourvieri* at sublethal concentrations of *Cx. quinquefasciatus* (0.0004 mg/l), *Ae. aegypti* (0.0006 mg/l) and *An. stephensi* (0.003 mg/l).

It is evident that hexaflumuron can be safely used at the rate of 1.0 mg/l in integrated pest management programmes without disrupting predator population and these predators will be additive in suppressing the mosquito populations without any damage to the natural control mechanisms.

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Biology of The Jassid *Balclutha Hortensis* Lindb. (Cicadellidae: Hemiptera) A Major Pest of Groundnut in India

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Abstract: The biology of the jassid *Balclutha hortensis* Lindb. infesting groundnut was studied under laboratory conditions. It has four instars and an adult stage. The female laid an average of 30 eggs and lived for 40 days from egg to death of the adult after oviposition, while the male lived 23 days. The female took 10 days for oviposition and the egg period lasted for 8 days. The sex ratio was 1.21:1 male and female.

Keywords: Biology, Groundnut jassid, *Balclutha hortensis*

INTRODUCTION

The Cicadellids popularly called as leaf hoppers and jassids are the major group of insects in groundnut under the Saurashtra area of Gujarat. There are sixteen Cicadellids recorded in groundnut in India of which *Empoasca kerri* Pruthi is the predominant pest (Amin, 1988). The other important species *Balclutha hortensis* Lindb. was reported as the major insect under Junagadh conditions (Nandagopal and Reddy, 1987). This insect has caused yield loss to an extent of 584 kg/ha when 120 jassids/m row present during the pod filling stage in the cv. JL 24 (Anon, 1989). This insect was reported feeding on 18 field crops including groundnut and nine weeds (Ammer *et al.* 1987) in Egypt. Except this, no information was available on this pest. Hence an experiment was conducted on the biology and morphomatrix, under laboratory and insectory conditions.

MATERIALS AND METHODS

Twenty day old groundnut seedlings of the cv. GG 2 were uprooted and washed the roots and all the leaves were removed leaving only terminal bud. The roots were wrapped with cotton wool and moistened. Two hundred such seedlings were marked for biological studies. Each of these seedlings were transferred to test tube (20 cm length and 3 cm diameter). One neonate nymph was released inside each tube and the mouth was covered with cloth secured with rubber band. The moulting was observed regularly at an hourly interval. For oviposition, a single seedling with one leaf (+1) was allowed

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and the remaining leaves were removed, introduced in to a tube and the adult female after mating was allowed to oviposit. Daily the seedling was changed and the old ones were collected in Dimethyl Sulphoxide (DMSO), processed and observed the eggs deposited into the tissue (Nandagopal and Soni, 1994). A reference culture of the same age group was also maintained separately for morphometric studies. The laboratory temperature and humidity was respectively 34°C ± 1.09 and 68% ± 6RH.

RESULTS AND DISCUSSION

An outbreak of *B. hortensis* during kharif 1986 had drawn our attention on this pest (Nandagopal and Reddy, 1987). Both nymphs and adults suck the sap of the tender stem and leaves mostly from under surface causing puckering and 'v' shaped yellowing which is similar to the symptoms caused by *E. kerri* (Amin, 1988). Males are generally smaller than females. The eggs are laid mostly inside the tissue of lamina, midribs and rarely in the tender stem. The egg was broad at apical and tapering towards the end. Four instars were recorded in both female and males followed by adult stage (Table 1). The different stages are given in Fig. 1. The morphomatric is given in Table 2.

Egg

It measured mean of 0.44 mm in length and 0.17 mm in width. The incubation period was from 6–12 days with a mean of 8.07 days (Table 1). Since the life history was traced from Ist instar, the identity of the sex of each individual was become possible.

First instar

The neonate nymph was yellowish green in colour and was having developed antennae. The male nymphs measured a maximum of 0.45 mm length and 0.23 mm width, while female was with 0.66 mm length and 0.29 mm width. Both male and female nymphs moulted within 12 h of hatching from eggs.

Second instar

The female instar took 1.16 days while male took 1.13 days to complete the instar. The males measured 0.57 mm length and 0.264 mm width.

Third instar

There was slight increase in the size of the male nymphs compared to female. This stage took 2.04 and 2.16 days respectively for female and males. Two small wing pads are clearly visible.

Fourth instar

The size of the insect increased to double to that of preceding instar. In the hind legs, spurs are seen from femur upto tarsus. The wing pads are expanded in size. The genital organs are visible. The male took 1.18 days while the female took 2.12 days. It measured 1.58 and 0.26 mm for male and 2.43 and 0.49 mm for female, length and width respectively.

Table 1
Biology of the jassid *B. hortensis*

Instar		number observed	duration (days) sd	range (days)
I	Female	30	12h	8.0–12.0
	Male	30	12h	8.0–12.0
II	Female	24	1.16±1.07	0.5–4.0
	Male	30	1.13±1.02	0.5–4.0
III	Female	24	2.04±0.14	1.0–0.4
	Male	28	2.16±0.17	2.0–5.0
IV	Female	22	1.18±0.11	1.0–2.0
	Male	26	2.12±0.12	2.0–4.0
	Female			
	Pre-oviposition period (days)	15	6.06±1.15	5.0–9.0
	Oviposition period (days)	12	10.03±0.18	9.0–11.0
	egg period (days)	40	8.07±1.16	6.06–12.0
	Post oviposition period (days)	12	3.0±1.18	1.0–6.0
	Adult longivity: (days)			
	Female	11	6.12±4.19	9.0–22.0
	Male	10	7.05±3.11	5.0–8.0
	Total life cycle (days)			
	Female		40.03	
	Male		23.00	

Table 2
Morphonatrix of *B. hortensis*

stage		no. min	length (mm) max	mean	sd	min	width (mm) max	mean	sd	
egg		40	0.43	0.46	0.44	±0.01	0.15	0.19	0.17	±0.04
Ist instar:	Male	25	0.43	0.52	0.45	±0.03	0.20	0.24	0.23	±0.04
	Female	25	0.65	0.68	0.66	±0.04	0.28	0.29	0.29	±0.07
II instar:	Male	25	0.56	0.58	0.57	±0.03	0.24	0.26	0.25	±0.04
	Female	25	0.81	0.90	0.86	±0.07	0.30	0.46	0.34	±0.05
III instar:	Male	25	0.64	0.69	0.67	±0.05	0.32	0.34	0.34	±0.06
	Female	25	1.67	1.93	1.78	±0.07	0.48	0.51	0.49	±0.08
IV instar:	Male	25	1.49	1.80	1.58	±0.08	0.36	0.38	0.36	±0.07
	Female	25	2.14	2.83	2.43	±0.10	0.48	0.49	0.49	±0.04
Adult:	Male	25	1.93	1.98	1.91	±0.04	0.56	0.60	0.57	±0.05
	Female	25	2.84	2.91	2.82	±0.07	0.64	0.69	0.67	±0.08

Adults

The female measured mean of 2.82 mm and the male only 1.91 mm. The female continue to be in pre-oviposition for an average period of 6.06 days with a maximum of 9 days. Oviposition started on 7th day after mating and continue oviposition for 10 days. It laid average of 30.16 eggs in its life (Fig. 2). The maximum number of eggs laid was during 3rd to 6th day of oviposition. A maximum of 6 eggs were laid in a single day. The sex ratio of isogeneic culture could not be studied, since we could not trace the entire eggs of a single female, since there was lot of mortality during the course of investigation and also we have to take the destructive sampling for observation of eggs. However, under field conditions the sex ratio was always high towards males (1.21: 1 Male: Female). The total life span of female was 40.03 days and it was 23 days for male.

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Histomorphological Studies And Bioassay Of Sex Pheromone Gland In Female *Pericallia ricini* F. (Lepidoptera: Arctiidae)

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Abstract: The main source of the sex pheromone in adult female *Pericallia ricini* is on the dorsal surface of the 9th abdominal segment. The glandular epithelium is found in the glandular sac dorsal to anus and on ventral surface of dorsal papillae anales and ventrally on the interior surface of the lateral papillae anale. These structures are spread apart by the eversion of the 8th and 9th abdominal segments which exposes the attractant producing epithelium to air. The epicuticle of glandular epithelium is covered with hollow outgrowths (spines) which provide large evaporative surface. The size of the gland cells is reduced after mating, which is related with the suppression of pheromone production.

Keywords: *Pericallia ricini*, Sex pheromone gland, Papillae anales, epicuticle, bioassay.

INTRODUCTION

The histological studies of female sex pheromone gland has been carried out in several species of Lepidoptera. The gland is usually situated dorsally or ventrally in the intersegmental fold between 8th and 9th abdominal segments in most of the species of Noctuidae (Percy and Weatherston, 1971; Feng and Roelofs., 1977; Gupta, 1979; Gupta and Brown, 1986).

In Arctiidae the source of sex pheromone and the histological studies of female sex pheromone gland has been reported by Mac - Farlane and Earle (1970); Brown (1989). The pattern of glandular structure has not become apparent in Arctiidae as the pheromone producing glands of only a few have been examined.

The present paper describes the bioassay, morphology and histology of the sex pheromone gland in *P. ricini* (F).

MATERIAL AND METHODS

Pericallia ricini (F.) is a pest of castor. The fully grown last instar larvae were collected and kept singly in glass jars. A piece of cheese cloth was tied over the mouth of the jar and the larvae pupated on the cloth. To locate the source of the sex pheromone,

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portions of abdomens of virgin female moths were excised with fine dissecting scissors. The various parts were then extracted with ether. Extracts were prepared of the dorsal and ventral regions of 9th abdominal segment. These regions (1 and 2 in fig. 1) did not include any of the intersegmental membrane between the 8th and 9th segments. A 3rd region included the 7th and 8th segments as well as the membrane between the 8th and 9th segments. Bioassays were accompanied by blank, solvents and calling female controls.

The attractiveness of each of these crude extracts was determined by bioassay. A glass jar containing 10 male moths was placed in diffuse light before the onset of responsiveness at ca. 9:0 P. M. Strips of filter paper impregnated with a known amount of crude extract of female moths were then introduced into the glass jar. The response was considered positive when the male became excited flew in erratic manner and tried to copulate with the source of pheromone and with one another. The tip of virgin female abdomen was removed, fixed in Carnoy's fluid and dehydrated with ethanol. The tissue was softened in methylbenzoate, cleared in benzene and embedded in paraplast. The blocks were sectioned at 8µm and the sections were stained with Delafield's haematoxyline and eosin was used as a counterstain.

RESULTS

The external morphological study of the 8th and 9th abdominal segments revealed no characteristic features that could be associated with the production of the pheromone. The 8th and 9th abdominal segments in their normal position are retracted into the 7th abdominal segment. The 7th abdominal segment of female *P. ricini* is covered with scales. Scales are absent on the 8th and 9th abdominal segments, but numerous setae and spines are present. The major part of the 9th segment is made up of pad like structures on either side of the anus and across the dorsum of the segment. These structures are called papillae anales (terminology of Ehrlich, 1960). For describing the location of sex pheromone gland, the papillae anales have been divided into the dorsal and lateral parts. (Fig. 1) There are no scales on the papillae anales, but the posterior edge of the dorsal part and all the lateral part is covered with long setae and spines.

The crude extract prepared from the dorsal part of the 9th abdominal segment (no. 1 in Fig. 1) continuously gave a strong positive male response in laboratory glass jar bioassays. When the pheromone laden filter paper was located in the glass jar; the males made vigorous circling movements on the filter paper and then tried to grasp it with their claspers, later on the males tried to copulate with each other. The crude extract prepared from lateral parts of the papillae anales elicited a weak response in males, indicating that some pheromone is present here also. The response treated weaker is that the male did not always make copulatory motions. The extracts from the 7th and 8th abdominal segments (including the membrane between the 8th and 9th segments) were unattractive to the males (Table 1).

The histological study revealed that the glandular structure is situated on the dorsal part of the 9th abdominal segment. The pad like structures are covering the whole dorsal and lateral parts of the 9th abdominal segment. These structures are called papillae anales. The dorsal papillae anale is like a sac. The glandular cells are also present on the ventral surface of dorsal parts of the papillae anales and ventrally on the interior surface of the lateral papillae anales. Therefore pheromone gland includes sac

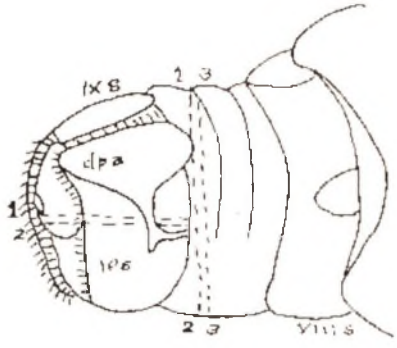

Fig. 1

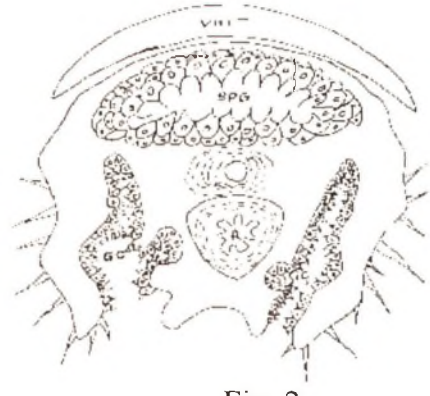

Fig. 2

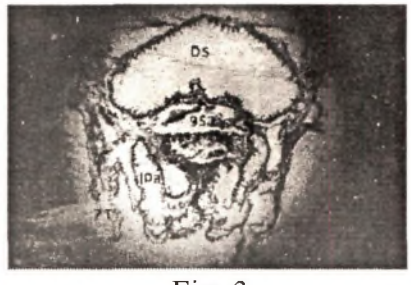

Fig. 3

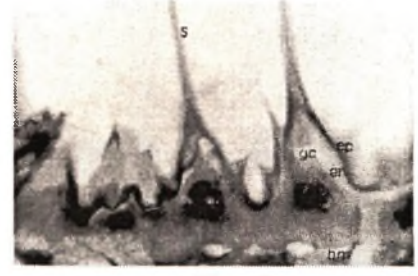

Fig. 4

Fig. 1. Dorsolateral view of the 8th and 9th abdominal segments. The numbers 1, 2 and 3 refer to the regions that were extracted and assayed for pheromone activity in *P. ricini* (Diagrammatic). VIIIs, 8th segment; IXa, 9th segment; dpa, dorsal papillae anales; lpa, lateral paillae anales. Fig. 2. T. S. of *P. ricini* (drawn from the slide with the help of camera lucida) to show the location of the gland cells. SPG, sex pheromone gland; R, rectum; GC, glandular cell; lpa, lateral papillae anales. Fig. 3. Tranverse section of last abdominal segment showing the dorsal sac and glandular cells on the papillae anales. 40×. DS, dorsal sac; lac, lateral papillae anales; 9sg, 9th segment; 7T, 7th tergum. Fig. 4. Glandular cells showing the large hollow spines on epicuticle. 1000×. bm, basement membrane; gc, glandular cell; N, nucleus; S, spine; ep, epicuticle; en, endocuticle.

like structure in the 9th abdominal segment, dorsal to anus and then upto and including the ventral surface of the papillae anales, and ventrally on the interior surface of the lateral papillae anales (Fig. 2 & 3).

The glandular epithelium is composed of large cells with distinct cell membranes. The cells are closely packed. The cells are mostly columnar. The height and diameter of gland cell and nucleus is given in Table 2. In one day old virgin female the glandular cells are 43–75 µm in length and 30–87 µm in width. The size of the cells decrease on the second day, which reveals the decrease of pheromone titre in the cells on the second day. The gland cells of the 2-day old mated and layed female measure approximately 14.62 µm in length. This shows that mating suppresses the pheromone production.

Table 1
Male responsiveness bioassay for female sex pheromone of *P. ricini*

Boassay Treatment	Male Response				Degree of Responsiveness
	Positive		Negative		
	No.	%	No.	%	
Blank Control	0	(0)	50	100	Nil
Solvent Control	0	(0)	20	100	Nil
Calling female	31	(89)	04	(11)	Strong Positive
Dorsal region of 9th abdominal segment	27	(90)	03	10	Strong Positive
Ventral region of 9th abdominal segment (including lateral papillae anales)	10	(50)	10	50	Weak Positive
7th and 8th abdominal segments along with intersegmental membrane between 8th and 9th abdominal segments	0	(0)	15	100	Nil

The procuticle is uniform in thickness. The epituticle is very thin and covered with numerous hollow outgrowths or spines. These are stained dark with eosine. The average length of spines is 66–37 μm. The spines provide appropriately large evaporative surface (Fig. 4). Some of the glandular cells contain a large irregular vacuole. It is observed that the rhythmic contractions of the last abdominal segments extrude the 8th and 9th segments and expose the attractant producing epithelium of *P. ricini*.

DISCUSSION

The sex pheromone producing glands of female noctuids studied so far consists of a modified intersegmental membrane between 8th and 9th abdominal segments (Percy and Weatherston 1974; Su and Lee 1977; Feng and Roelofs, 1977; Gupta and Brown 1986). The glandular structure is different in *P. ricini* than the above described noctuids. In *Pericallia ricini* the glandular structure is situated on the dorsal part of the 9th abdominal segment, which is the main source of pheromone. The glandular cells are also present on the ventral surface of the dorsal papillae anale and ventrally on the interior surface of the lateral papillae anales. The terminology of Ehrlich (1960) is used for these structures. The structure resembles with the *Estigmene acrea* (Mac-Farlane and Earle, 1970). In *Asura conferta* the female sex pheromone gland is originated from the inter-segmental membrane between 8th and 9th abdominal segments. The gland lies in the body cavity as an invagination which penetrates deep into 8th segment and opens

Table 2
Height and diameter of gland cell and nucleus, length of spine; thickness of cuticle; presence of vacuoles in female sex pheromone gland of *P. ricini*

Age	Length of cell µm		Width of cells µm		Length of nucleus		Width of nucleus µm		Length of spines µm		Thickness of cuticle µm	Presence of vacuoles in cytoplasm
	Mean	Range	Mean	Range		Mean	Range	Mean	Range			
1-day old V. female dorsal gland	43.75	39 to 48.75	30.87	29.25 to 32.50	9.75	11.37	9.75 to 13.0	66.37	19 to 113.75	3.25		vacuoles are present
Lateral gland	35.75	32.50 to 39	29.75	29.25	9.75	11.37	9.75 to 13.0	19.50	6.50 to 32.50	–		few vacuoles are present
2-day old V. female	35.75	32.50 to 39	25.62	22.00 to 29.25	9.25	11.37	9.75 to 13.0	54.50	19.0 to 90.0	3.25		few valuoles are present
2-day mated & layed female	14.62	13 to 16.25	14	3 to 16	6.50	–	6.50 to 7.00	could not measured. distorted	–	–		no vacuole

dorsally in intersegmental fold between 8th and 9th segments as in *Utetheisa* (Brown 1989).

The spines are reported in *E. acrea*, which may help in dispersing the pheromone (Mac-Farlane and Earle, 1970). In addition to this they could serve to prevent localized collapse of the glands during glandular compression and to effect elastic re-expansion of the glands cells may provide large evaporative surface and could serve to prevent collapse of gland during glandular compression. In *Asura conferta* the spines are very small (ca. 12 µm) in comparison to *P. ricini*, the gland collapses on the second day of its emergence in *Asura*. It reveals that the size of the spine in glandular cells is correlated with the secretory activity of the pheromone producing female gland.

In *P. ricini* the gland is not exerted but the rhythmic contractions of last abdominal segment exposes the attractant producing epithelium as in *E. acrea*. (Mac-Farlane and Earle 1970).

The size of the cells decrease on the second day which reveals the decrease of pheromone titre. The gland cells of mated and layed females are reduced in size. Height of the gland cells of *T. ni* are reported to be correlated with the secretory activity of the cells in pheromone secretion (Jefferson and Rubin, 1973). Webster and Carde (1984) reported mating in *P. stultana* resulted in termination of calling, same is reported in *Asura conferta* (Brown, 1989). It is revealed by this study that mating suppresses the pheromone production, consequently the size of glandular cells are reduced after mat-

ing.

The pheromone producing glands of only a few Arctiids have been examined. Many more species of family Arctiidae must be examined before a clear understanding of the methods of pheromone production and release are understood.

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Biometrical Analysis Of Larval Growth During The Development of *Apis mellifera* L. (Hymenoptera: Apidae)

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Abstract: Seven characters were measured during the larval development of *Apis mellifera* L. worker bees. Head width, body width at 2nd (B-2) and length at 10th (B-10) body segment of the larvae showed isometric growth, whereas body width at 10th segment +ve and head length and body length at 2nd segment - ve allometry. The findings suggested the applicability of Dyar's recommendations. Colour changes during the pupal stage are also briefly described.

Keywords: *Apis mellifera* L. larval development, biometrical analysis.

INTRODUCTION

The *Apis mellifera* L. had a large area of distribution extending from Southern Scandinavia to Cape of Good Hope in the South, from Daker in the west to Urals, Mashed and coast of Oman in the East (Ruttner & Louveaux, 1978). It has been introduced into various countries of the world viz. America, South America, South Africa, Australia, New Zealand, Japan, Formosa etc. keeping in view of its superiority in physical characteristics over *A. cerana* F., it has also been introduced successfully in India during 1962–65 (Atwal & Sharma, 1968). After its introduction in India, a good work on its management practices were undertaken, but the biometrical information on the larval growth of *A. mellifera* worker bees has not been reported. Earlier Nelson (1915) and Du Praw (1960) described the embryology of honey bee. Bertholf (1925) discussed moulting during larval development of *A. mellifera*. Nelson (1924) and Snodgrass (1975) described comprehensively the morphological features of mature larva. Colour changes in honey bee pupae was described by Wedmore (1945). The present study provides biometrical information to numerical taxonomists on larval growth of *A. mellifera* from its new acclimatized home *i.e.*, India. The study was necessary because *A. mellifera* in India is in its advanced stage of hybridization as the queens from different countries viz. Italy, England and USA were imported and tested during its introduction in India (Atwal & Sharma, 1968). Further, this will also help the persons working with bees to recognize biometrically the different larval stages of *A. mellifera*.

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MATERIALS AND METHODS

Larval stage of known age were obtained by providing newly raised combs to laying queen for egg deposition. These combs were inspected regularly at 4hrs interval for laid eggs. When the laying was noticed, the area of cells containing eggs were marked. A number of such combs were maintained in *A. mellifera* colonies for the completion of investigation. Ten larvae were carefully taken out as soon as the hatching was noticed and after that twice in a day *i.e.*, 10 am and 5 pm till the formation of pupae. Pupae were obtained once in a day at 10 am to know its colour changes. Larvae were killed in boiling hot water and alighted to ocular/stage micrometer to obtain length and width of head, length of the second (B–2) and tenth (B–10) body segments, body width at B–2 and B–10. The total body length of larvae worked out from camera lucida sketchings. The ratio of increases and progression factor are calculated as described by Kumar (1990). Linear relation, $\log y = a + bx$, where 'y' is the measured value of the character, 'x' the number of instar, 'a' a constant and 'b' is the logarithm of the growth ratio, has been used to describe the geometrical growth of head width. Notation $y = bx^a$ by which the size of an organ 'y' is expressed as a function of body length 'x', with a and b as constants denoting growth ratio and initial growth index, respectively, has been used for allometric growth analysis.

The above studies were conducted at Nagrota Bagwan (907 masl, 32°7′ N latitude, 76° 24′ E (longitude). The ambient maximum, minimum temperature and relative humidity averaged 27.4±2.09°C, 21.5±1.09°C and 87.20±9.65% respectively, during the course of study.

RESULTS AND DISCUSSION

0 day eggs were whitish, tubular slightly curved, measured 1.500±0.014 mm in length and 0.323 ±0.016 and 0.339±0.023 mm in diameter towards basal and apical ends, respectively. The smaller end adhered to the cell base, the maximum diameter appeared near the apical end. On the third day, when hatching, the eggs were 1.523 ± 0.045 mm in length 0.332 ±0.017 and 0.367±0.024 mm in diameter towards basal and apical ends respectively. The average measurements of the eggs recorded during these studies were almost in agreement to 1.4×0.4 mm, reported by Wedmore (1945). However, slight increase in their length and width 0.023 and 0.028 mm, respectively, during incubation period might be attributed to the larval formation in the egg.

The newly hatched larvae were tubular whitish in colour, having a curved 'c' shape. All the characters metrically increased during successive days of development. The measurements of these characters averaged during successive days are presented in Table (1). On the fifth days of larval development, bees started raising the border of cells for capping them and the larvae were curved in 'C' shape (coiled). On the sixth day when the cells were uncapped for larval measurements, larvae were found uncoiled, lying with ventral side up in the cells. This stage continued for next day too. On the eighth day external pupal organs started taking their shape and were visible under the unsheded larval cuticle in eight larvae out of ten taken for measurements, so the stage on this day is called 'pharate' stage. The length and width of head of the unsheded larval skin averaged 1.615 ± 0.039 mm and 1.726 ± 0.023 mm respectively. The larval body segments were distinguishable only in four out of ten larvae and their length at

B–2 and B–10 averaged 0.978± 0.039 and 1.683 ± 0.102 mm, respectively. The total larval body length averaged 19.475 mm and width 3.276 ± 0.000 and 4.345 ± 0.175 mm at B–2 and B–10, respectively.

The declining trend in the ratio of increase (RI) (2.14 to 1.01) towards the terminating larval period (Table 1) reveals three phases of growth during the larval period. The first phase of maximum growth during first two days. (RI = 2.14), second of moderate growth (RI = 1.44 & 1.42) up to the starting of sealing and third with negligible gains (RI = 1.13, 1.09 & 1.01). Thrasyvoulon & Benton (1982) also reported different growth rates during larval development while studying the weight of honey bee larvae at definite age intervals. Harries & Henderson (1938) observed biometerically that different growth phases may occur during the insect development.

The larval head width measurements during successive days of development are given in Fig. 1. The difference in the measurements of four groups are sufficiently high to reliably assign each growth a 'stage'. This shows that the larvae of *A. mellifera* worker moulted four times and passed through four instars. The first three moults took place almost at 24 hrs interval whereas the fourth or final moult on 3rd day of 24 sealing after which larvae became pupae. The observation presented here holds variation as five moults and five instars has been reported for *A. mellifera* (Bertholf, 1925) and *A. cerena* (Mishra & Dogra, 1980). they observed that the larvae of *A. mellifera* and *A. cerana* moulted four times before sealing and the final fifth moult which marks the commencement of pupal stage occurred after sealing. However, the present study did not reveal the fourth moult before sealing. If this had happened the head width of fifth and succeeding days much have shown a marked tendency to exceed from the head width observed on fourth day. Contrary to this head width averaged 1.619 and 1.599 mm during 5th, 6th and 7th days, respectively, showing a close affinity to the value observed during fourth day. Moreover, the head width of the unsheded exuviae of 'pharate' stage represented the same group (Fig. 1&2). The apparent lack of usual increase shows that no moult occurred during these days. A perfect geometrical progression of head width is presented by plotting the logarithms of the head width against each instar. The equation $\log y = -0.7224 + 0.2414x$ gave a best fit regression line. The approximation of the observed and calculated head ($\chi^2 = 0.0236$, insignificant at 1% level), is suggestive of applicability of Dyar's law to assign the larvae of *A. mellifera* from random collection to their proper instar. Further the best fit regression line along with the consistency or head width measured during successive days evidenced that no moult had been accidentally missed throughout the larval development.

The progression factor describes the growth trends of different characters during larval period. For different body characters it ranged 1.28 to 1.43 with an average value of 1.37 (Table 1). The larval body width at B–10 showed positive allometric growth ($a>1$), head width, body length of B–10, body width at B–2 showed approximately an isometric growth ($a=1\pm0.1$) whereas the head length and length of B–2 had a negative allometry($a<1$). Significantly high coefficients of correlation between logarithm of the total larval body length and other characters indicated that the equation $y = ab^x$ very well describes larval growth patterns in *A. mellifera* (Table 2).

White coloured, delicate, unsclerotised pupa with distinct but nonpigmented eyes were found from the cells opened on the 9th and 10th days. Their head width was 4.325±0.029 mm. the eyes became yellowish on the 11th day and violet on the 12th

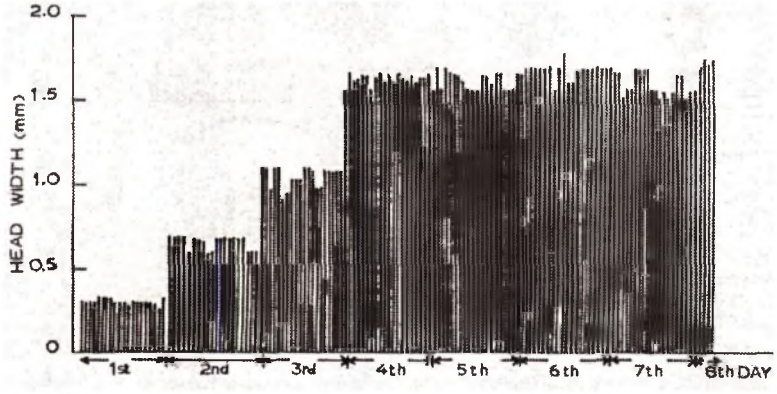

Fig. 1

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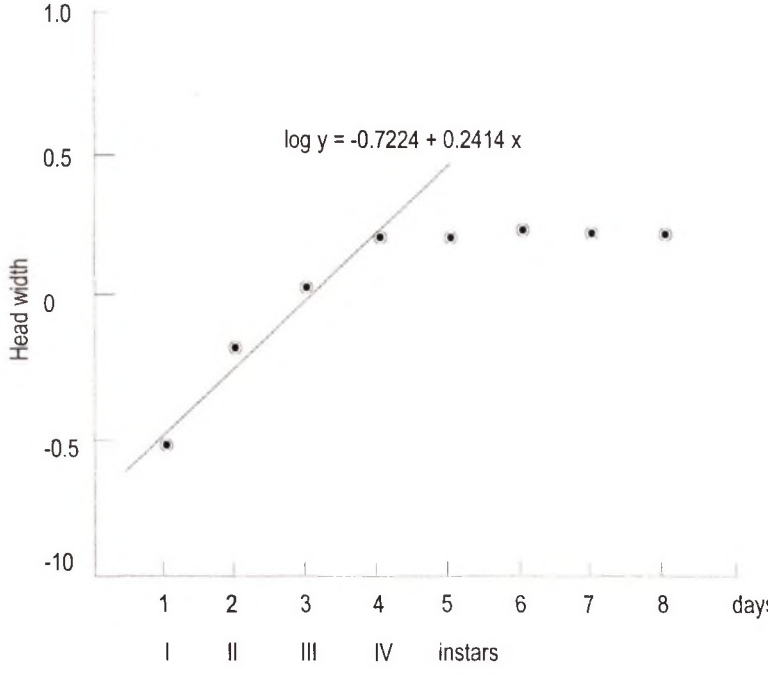

Fig. 2

Fig. 1. Distribution of larval head width of *Apis mellifera* worker during successive days of development. Each bar represents head width of a larva. Fig. 2. Logrithms of mean head width of larvae during successive days of development of *A. mellifera* worker and best fit regression line based on mean head width of larvae during successive instars.

Table 1
Measurements (mm) or different body parts of *Apis mellifera* workers larvae during successive days of its development

Sl. No.	Days / Character	1	2	3	4	5	6	7	Progression factor
1.	Head Length	0.048 ±0.080	0.732 ±0.104	0.961 ±0.050	1.302 ±0.197	1.349 ±0.045	1.537 ±0.063	1.601 ±0.109	1.28
2.	Head width	0.299 ±0.021	0.654 ±0.038	1.047 ±0.060	1.632 ±0.027	1.619 ±0.052	1.689 ±0.049	1.599 ±0.071	1.39
3.	B–2 Length	0.223 ±0.072	0.471 ±0.042	0.621 ±0.128	0.760 ±0.124	0.839 ±0.188	0.982 ±0.171	0.991 ±0.085	1.32
4.	B–10 length	0.276 ±0.090	0.676 ±0.064	0.967 ±0.193	1.375 ±0.189	1.686 ±0.190	1.674 ±0.264	1.619 ±0.089	1.41
5.	Total body length	3.671 ±1.138	8.511 ±0.684	12.278 ±2.095	16.551 ±0.516	19.347 ±1.262	19.323 ±0.561	19.829 ±0.672	1.38
6.	Body width at B–2	0.618 ±0.147	1.250 ±0.066	1.807 ±0.199	2.603 0.219	2.821 ±0.154	3.294 ±0.089	3.374 ±0.144	1.36
7.	Body width at B–10	0.580 ±0.171	1.214 ±0.074	1.851 ±0.225	2.972 ±0.414	3.779 ±0.187	4.104 ±0.341	4.195 ±0.160	1.43
	Ratio of increase (RI) between the mean for each day & one next preceding	2.14	1.44	1.42	1.43	1.09	1.81		1.37

Mean value ± SD

Table 2
Comparison or different characters with larval body length in *A. mellifera* worker

Sl. No.	Character	Growth ratio (a)	Initial growth index (b)	Coefficients of correlation (r)
1.	Head length	0.7865	0.1417	0.9921
2.	Head width	1.0474	0.0751	0.9932
3.	B–2 length	0.8254	0.0790	0.9655
4.	B–10 length	1.0724	0.0680	0.9984
5.	Body width at B–2	0.9912	0.1612	0.9926
6.	Body width at B–10	1.1852	0.1107	0.9875

Significant value for 'r' at 1% level = 0.6215

day, brownish on the 13th day and then darkened on the 14th day. Pupal body was non-pigmented till 12th of post embryonic development. On 13th day, body was pigmented pale yellow. On the 15th and 16th day pupae were characterized with darkening of thorax and abdomen respectively, Wings were fully developed on 16th day of postembryonic development. The emergence from few cells was noticed at 5 pm on 17th day. The colour changes during the pupal period is in agreement to the earlier reports on honeybees. (Wedmore 1945, Mishra & Dogra, 1980). The total developmental period of *A. mellifera* workers between 20–21 days is also almost similar to that reported by Bertholf (1925) and Wedmore (1945). However, the deviations observed from the earlier findings may be attributed to the developmental responses to the ecological conditions and probably the hybridization which might have occurred during the introduction of *A. mellifera* in India.

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Indoor Rearing of Oak Fed Silkworm *Antheraea proylei* Jolly

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Abstract: Oak tasar larvae of *Antheraea proylei* Jolly were reared indoor on cut shoots of *Quercus serrata* Thunb. The relative growth rate and relative nitrogen accumulation rate were significantly better when the worms were fed on cut shoots supported with water filled containers in comparison with floor feeding without support of water filled containers. It is recommended to conduct rearing of Oak Tasar larvae indoor to increase the effective rate of rearing from the average recovery of 40% outdoor to 76.7% indoor in the North-Eastern India.

Keywords: Rearing, Oak, tasar, Silkworm

INTRODUCTION

There exists an inexhaustible potential for the production of Oak Tasar Silk, due to vast acreage of Oak forests available in sub - Himalayan India (Jolly *et al.* 1969). However, Oak Tasar Crops remain uncertain at field level due to various problems (Noamani, 1993), One of the problems has been hazards of outdoor rearing. Indoor rearing of Oak Tasar larvae in the North Eastern region is reported here.

MATERIAL AND METHODS

The Oak Tasar Silkworm *Antheraea proylei* J. is cultivated at Regional Tasar Research Station, Imphal since 1970 (Jolly *et al.* 1969). The eggs were obtained from the grainage in the last week of February. These were disinfected with 4% formalin. Later on, eggs were kept in an electric incubator maintained at 25± 2°C with 80± 5% relative humidity. Under these hygrothermic conditions, hatching of worms began on 9th day and was completed by 11th day of incubation. Rearing was conducted by bringing young shoots about 2 feet long and 3–4 branches were inserted in water filled tin containers of 20 litre volume. Mouth of the containers was plugged with old newspaper pieces after inserting the twigs to prevent crawling of the worms inside the containers. These were kept in the rearing hall of physiology section of R. T. R. S., Imphal. Invariably, first day hatching was mounted on one container to facilitate moulting synchronously. Only 500 worms were mounted on each container. Next day hatching was mounted on separate containers. At this population density, first instar rearing was completed without

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Table 1
Analysis of Growth During Indoor Oak Tasar Silkworm Rearing

Nutritional Index	Indoor Rearing Method			
	Feeding on cut shoots dipped in water filled tin containers	Floor feeding under polythene cover	Floor feeding without polythene cover	CD at 5%
RCR (mg/mg/day)	11.49	12.50	10.03*	1.79
RGR (mg/mg/day)	1.09	0.99*	0.84	0.01
AD (%)	45.00	44.11	33.62	17.86
ECD (%)	19.17	20.68	17.87	11.70
ECI (%)	10.70	8.34	8.34	5.3
RNCR (mg/mg/day)	0.55	0.35*	0.26	0.03
RNAR (mg/mg/day)	0.10	0.11	0.08	0.013
NUE (%)	29.36	32.58	30.55	11.67

* Significantly different at 5% level from other mean values in the same line.
ECR = Relative Consumption Rate; RGR = Relative Growth Rate; AD = Approximate Digestibility; ECD = Efficiency of Conversion of Digested Food; ECI = Efficiency of Conversion of Ingested Food; RNCR = Relative Nitrogen Consumption Rate; RNAR = Relative Nitrogen Accumulation Rate; NUE = Nitrogen Utilization Efficiency.

Table 2
Comparative Results of Indoor And Outdoor Rearing Of Oak Tasar Silkworm

	Complete outdoor	Indoor on tin containers	Indoor floor feeding under polythene cover	Indoor floor feeding without polythene
Effective rate of rearing (%)	40.00*	76.6	70.00	37.40*
Average cocoon weight (gm)				
Male	5.21	5.14	4.89	4.61*
Female	6.28	6.03	6.02	5.22*
Average shell weight (gm)				
Male	0.61	0.62	0.58	0.49*
Female	0.68	0.64	0.61	0.52*
Average shell ratio (%)				
Male	11.70	12.06	11.86	10.62*
Female	10.82	10.60	10.13	9.96*
Fecundity (Average no. of eggs)	116	114	102	88

* Significantly different at 5% level from other mean values in the same line.

any transfer to other tin. On consumption of foliage, fresh shoots were attached on tins and consumed shoots were taken out at 24–h intervals. The room was cleaned daily to remove excreta. In another method, cut shoots were not inserted in water filled tin containers but covered with a thin polythene sheet on the floor. Thirdly, worms were reared on floor without polythene cover and without support of water filled tin containers. The following nutritional indices were calculated on a dry weight basis using the procedures of Walbdauer (1968). Mean larval Biomass is defined as the average of the sum of the initial and final dry weight of the larvae.

Relative Consumption Rate:
RCR (mg/mgday) = food ingested per unit mean larval biomass per day.

Relative growth Rate: RGR (mg/mg/day) = biomass gained per unit mean larval biomass per day = (RCR) (ECI)/100

Approximate Digestibility:
RD(%) = 100 (Food ingested-feces)/food ingested.

Efficiency of Conversion of Digested Food
ECD(%) = 100 (biomass gained)/food ingested-feces).

Efficiency of Conversion of Ingested Food:
ECI(%) = 100 (biomass gained)/Food ingested
= (AD) ECD)/100.

Relative Nitrogen Consumption Rate:
RNCR (mg/mg/day) - biomass nitrogen ingested per unit mean larval biomass per day.

Relative Nitrogen Accumulation Rate:
RNAR (mg/mg/day)= biomass nitrogen gained per unit mean larval biomass per day.

Nitrogen Utilization Efficiency:
NUE (%) = 100 (biomass nitrogen gained)/nitrogen ingested.

Mean differences were derived from standard ANOVA procedures (Sokal and Rohlf, 1969).

RESULTS

The growth analysis of three methods of indoor rearing is presented in Table 1. It can be seen from the observations, that relative consumption rate declined significantly when the worms were reared on floor without polythene cover. The relative growth rate, relative nitrogen accumulation rate were best when the worms were fed on cut shoots supported with water filled tins and significant decline occurred in these nutritional indices, when the worms were reared on floor without support of water filled tins. The differences in approximate digestibility, efficiency of conversion of digested food, efficiency of conversion of ingested food and nitrogen utilisation efficiency were insignificant. These results show the most suitable method for indoor rearing was feeding the worms throughout on shoots either supported with water filled containers or on floor under polythene cover. In the outdoor method of rearing only 40% of the worms brushed

survived, whereas in complete indoor rearing 76.06% survival was achieved on tins. In floor feeding under polythene cover, 70% survival was observed but without polythene cover only 37.4% survival was achieved due to retarded growth.

It can be seen from Table II that the cocoon quality and fecundity of the indoor rearing was comparable to outdoor raised cocoons. Nevertheless, the survival as well as cocoon quality declined in the indoor floor feeding without polythene cover.

DISCUSSION

For complete indoor rearing of a thousand layings, two rooms of 200 sq. ft. size are required. This is one of the handicap of indoor rearing because the farmers do not have sufficient dwelling accommodation even for their other family needs. Complete indoor rearing also requires a large working force for bringing out shoots from the forest and for cleaning of the rooms to remove excreta and left over shoots. The economics of income per family on the basis of 1000 laying indoor rearing is presented in Table III. It is recommended to conduct atleast chawki rearing indoor to prevent loss of young larvae. Nevertheless, complete indoor rearing can increase the cocoon yield from the average recover of 40% outdoor to 76.6% indoor. Thus, seed rearings should preferably be taken completely indoor to save Oak Tasar Culture.

Table 3
Economics of Indoor Oak Tasar Silkworm rearing per hectare

I. Plantation:-			
i.	Land and plantation	:	naturally available
ii.	Digging and weeding (20 mandays @ Rs. 35/- per day)	:	Rs. 700/- (family labour)
iii.	Pruning (15 mandays)	:	Rs. 525/-
iv.	Farm implements	:	Rs. 150/-
v.	Cost of fertilizers	:	Rs. 550/-
vi.	Fertilizer application	:	Rs. 1050/-
	Total	:	Rs. 2425/-
II. Rearing:-			
i.	Rearing house	:	Own dwelling
ii.	Tin containers (20 nos. @ Rs. 16/- each)	:	Rs. 320/-
iii.	Bamboo trays 2 nos. ($2' \times 4'$ Rs. 25/- each)	:	Rs. 10/-
iv.	Secatures 2 nos. (@ Rs. 25/- each)	:	Rs. 50/-
v.	Cost of dfls (1000 dfls)	:	Rs. 100/-
vi.	Rearing labour, 55 mandays	:	Rs. 1925/-

	Total	:	Rs. 2405/-
III. Production details:-			
i.	Total cocoon yield (No.) @ 30/dfl	:	30000
ii.	Sale proceeds of cocoons @ Rs. 0.15/- each)	:	Rs. 4500/-
iii.	Sale proceeds of pruned branches	:	Rs. 200/-
	Total	:	Rs. 4000/-
IV. Cost/Benefit ratio:-			
(a)	Fixed capital investment		
(i)	Agriculture implements	:	Rs. 100/-
(b)	Working investment		
(i)	Maintenance of plantation including pruning, digging, weeding and fertilizer application.	:	Rs. 2275/-
ii.	Cost of rearing material	:	Rs. 380/-
iii.	Cost of fertilizer		Rs. 550/-
iv.	Rearing labour	:	Rs. 1925/-
v.	Cost of dfls		Rs. 100/-
	Total	:	Rs. 5230/-
(c)	Sale proceeds	:	Rs. 4700
(d)	profit per annum per prop	:	Rs. 530/-(–)
(e)	Net profit	:	Rs. 3670/-
	Cost	:	Rs. 5330/-
	Income	:	Rs. 4700/-
	Cost benefit ratio	:	Rs. 1.13:1

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Life Table of Uzifly *Exorista bombycis* Louis (Diptera: Tachinidae) Parasitizing 2nd stage Larvae of Silkworm, *Bombyx mori*

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Abstract: The life table of Uzifly, *Exorista bombycis* was constructed through 3 generations using 2nd stage silkworm larvae as host for depositing eggs with the different biotic characters like mortality at every stage of its life cycle, pupal period, adult longevity, fecundity fertility and sex ratio in relation to the abiotic factors (temperature and relative humidity) prevailing in the rearing room. Generation survivability was recorded to be varied from 4.44% to 7.04%. Maximum mortality at egg, larval, maggot and pupal stages was 66.02%, 46.94%, 7.69% and 20.83% respectively. Fertility and Sex-ratio were found to be varied from 28.57% to 33.33% and 1:0.77 to 1:1.1 respectively. Correlation of coefficient between the biotic and abiotic factors was also made. Effects of parasitization on young silkworm larvae and the survival rate of the parasitoid during every stage of its life cycle have been discussed.

Keywords: Uzifly, life table, 2nd stage silkworm larvae, Survivability, Abiotic factors.

INTRODUCTION

Uzifly, *Exorista bombycis* (Louis) is a parasitoid of the silkworm. *Bombyx mori* (Mukherjee, 1899; Jameson, 1922; Ghosh, 1949 and Dasgupta, 1962) causing menace to the silk industry in West Bengal and Southern states of India (Jolly 1981). Uziflies prefer to deposit eggs on older larvae, particularly the IV instar worms followed by III and V instar worms (Siddappaji 1985). Gangwar and Thangavelu (1988) first reported the incidence of uzi infestation on young silkworm larvae (II instar) of *B. mori* in Tamil Nadu. Although there is a common idea among the farmers that young age silkworms are not infested by Uzifly, II stage larvae during chawki rearing were also found to be parasitized by the parasitoid in sericulture area of Malda District, West Bengal Perusal of literature revealed that Datta and Mukherjee (1978) studied the life history of *Tricholyga bombycis* after oviposition on late stage worms. Patil and Govindan (1984 and 1986) and Kumar and Jolly (1986) studied the effects of temperature and humidity on the developmental stages of *E. sorbillans*. Valovage and Kulman (1986) prepared the life table of *Bessa harveyi* on *Pikonema alaskensis*. Bhattacharya *et al.* (1993) constructed the life table of *E. sorbillans* parasitizing on V stage silkworms. But life table

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of *E. bombycis* on infesting II stage silkworm larvae was not studied so far. Therefore, our present investigation was aimed at studying the life table of Uzifly parasitizing on II instar silkworm larvae. * Nomenclature of the Indian Uzifly is now finally established as *Exorista, bombycis* (Louis) (Siddappaji & Basavanna 1990).

MATERIALS AND METHODS

Maintenance of generation

For preparing the life table, the Uzifly population was maintained in the laboratory by collecting maggots of *E. bombycis* from commercial rearing zones of Malda district. After emergence the adult flies were kept in 60×60×60× cm muslin netted cages with a circular muslin sleeve covered passage. 10% glucose solution in cotton swab, which served as a food for the Uziflies was placed in a petridish and kept inside the cage (Sriharna *et al.* 1980). For studying a generation of the Uzifly, 100, II stage larvae of *B. mori* and two pairs of mated male and female flies were kept in a cage of oviposition. After 24 hrs of ovipositional exposure the infested larvae were taken out of the cage and reared in a tray having wire netted covering.

Mortality at every stage

To record mortality at every stage of the fly for every generation, the parasitized silkworm larvae were examined and the total number of eggs oviposited was noted. On hatching of uzi eggs, black scars appeared on the skin of the silkworms due to penetration of the newly hatched Uzifly larvae (*i.e.*, first instar) into the host body. The number of black scars was deducted from the total number of eggs laid by a Uzifly and thus percentage of unhatched eggs was calculated, which was considered as the mortality during egg stage. Mortality during larval stage (first and second instars *i.e.*, parasitic stage of Uzifly) was calculated from the deduction between the number of eggs hatched and the number of maggots came out the host. Maggot mortality was assessed on the basis of number of maggots transformed into puparia. Similarly, pupal mortality was calculated from the emergence of adult flies.

The dead individuals of all the developing stages were examined thoroughly to find out the reasons for mortality, but the reasons for unhatched eggs whether due to non fertilized eggs or embryo died in an early stage, could not be studied.

Fertility of female fly

On emergence, 5 pairs of male and female flies were randomly selected from the stock and each pair was kept in a separate cage for copulation and oviposition. The number of fertile female flies was recorded on the basis of hatching of eggs which were laid by the flies on the body of the host.

Survival rate at every stage of the uzifly for every generation was assessed according to Harcourt (1969).

For studying the life cycle of the parasitoid duration of different developmental stages, length and weight of the puparia and adult longevity were recorded.

Correlation of coefficient among the abiotic and biotic factors of uzifly was determined.

Table 1
Life table of uzifly (*E. bombycis*) after laying eggs on II stage silkworm larvae
Generation I

	No. of Individual	Mortality (No.)	Mortality (%)	Survivability (%)
Eggs	108	59	54.63	45.37
Larva	49	23	46.94	53.06
Maggot	26	2	7.69	92.31
Pupa	24	5	20.83	79.17
Adult	19			
Female (Fertile)	10(4)			40.00
Fecundity	70			
Sex ratio	1:1.1			
Generation survivability	7.04			

RESULTS AND DISCUSSION

The results of investigation on the biotic potentiality of *E. bombycis* after infestation on II stage silkworm larvae are discussed below.

Egg stage

Egg mortality varied from 54.60% to 66.02% (Table 1, 2 and 3). Bhattacharya *et al.* (1993) reported that after oviposition on V stage worms, egg mortality ranged from 15.6% to 51.8% which was found to be negatively correlated with maximum and minimum temperature at 1% level and maximum humidity at 5% level. In the present study egg mortality was observed to be negatively correlated with maximum and minimum humidity at 1% level (Table 4).

An average incubation period was found to be 2.9 days (range 2.6 to 3 days). Datta and Mukherjee (1978) reported the average incubation period of 2.45 days. Kumar and Jolly (1986) recorded the average incubation of 2 days (range 30 hrs to 60 hrs).

Larval stage

Larval mortality was found to be minimum 40.0% and maximum 46.94% (Table 3 and 1). It was positively correlated with all the four abiotic factors at 1% level (Table 4). Bhattacharya *et al.* (1993) reported that larval mortality ranged from 7.2% to 30.86% when the host was V stage silkworm larvae.

Two larval stadia of the parasitoid (I and II instars) passed inside the body of the host in 5.2 to 6.3 days (average 5.6 days).

Maggot stage

Maggot mortality was recorded to be minimum and maximum 4.76% and 7.69% (Table 3 & 4) respectively. Bhattacharya *et al.* (1993) reported the maggot mortality which

Table 2
Life table of uzily (*E. bombycis*) after laying eggs on
II stage silkworm larvae
Generation II

	No. of Individual	Mortality (No.)	Mortality (%)	Survivability (%)
Eggs	114	69	60.53	39.47
Larva	45	19	42.22	57.77
Maggot	26	2	7.69	92.31
Pupa	24	4	16.66	83.34
Adult	20			
Female (Fertile)	9(3)			33.33
Fecundity	74			
Sex ratio	1:0.82			
Generation survivability	5.84			

Table 3
Life table of uzily (*E. bombycis*) after laying eggs on
II stage silkworm larvae
Generation III

	No. of Individual	Mortality (No.)	Mortality (%)	Survivability (%)
Eggs	103	68	66.02	33.98
Larva	35	14	40.00	60.00
Maggot	21	1	4.76	95.24
Pupa	20	4	20.00	80.00
Adult	16			
Female (Fertile)	7(2)			28.57
Fecundity	79			
Sex ratio	1:0.77			
Generation survivability	4.44			

Table 4
Interrelationship among the abiotic factors and biotic factors of uxifly during the study of generation after laying eggs on II stage silkworm larvae

Biotic Parameters of Uzi Fly	Temperature		Relative Humidity	
	Maximum	Minimum	Maximum	Minimum
Mortality at egg stage	-0.8951**	-0.9000**	-9023**	-0.9926**
Mortality at larva stage	0.7982**	0.80492**	0.8080**	0.9535**
Mortality at Maggot stage	0.9966**	0.9956**	0.9951**	0.9121
Mortality at pupal stage	-0.2495	-0.2388	-0.2336	0.0879
Male longevity	-0.2079	0.2111	0.2126	0.2874
Female longevity	0.3147	0.3157	0.3161	0.3239
Fecundity	-0.2638	-0.2647	-0.2651	-0.2772
Fertility	0.8589**	0.8646**	0.8673**	0.9806**
Sex ratio	0.9686**	0.9714**	0.9725**	0.9960**
Generation Survivability	0.9225**	0.9264**	0.9284**	0.9984**

**Significant at 1% level

ranged from 0.0% to 10.3% was negatively correlated with the four abiotic factors. In the present findings maggot mortality was positively correlated with all the four abiotic factors at 1% level which is contradictory to the observation made by Bhattacharya *et al.* (1993).

Transformation of maggot into puparium was found to be completed in 0.21 day. However, Datta and Mukherjee (1978) reported the maggot period of 0.30 day in average.

Pupal stage

Pupal mortality was found to be minimum 16.66% and maximum 20.83% (Table 2 and 1). There was no significant correlation observed between the pupal mortality of uzifly and any of the four abiotic factors. This is in agreement with the report made by Bhattacharya *et al.* (1993).

Pupal size varied from 4.5 mm to 6.0 mm and the weight from 0.078 gm to 0.078 gm while the normal pupal size varied from 9.0 mm to 12.0 mm and weight from 0.59 gm to 0.71 gm. Datta and Mukherjee (1978) reported the average parasitoid pupal period of 10.9 days. In the present investigation the average pupal period was recorded 10.7 days.

Male and female longevity

Maximum longevity of male and female uziflies was recorded to be 3.9 days and 5.3 days respectively. Datta and Mukherjee (1978) reported that average longevity of adult flies was 10.6 days (range 10–20 days). Kumar and Jolly (1986) observed that the longevity of female flies 15.39 days. Sriharan *et al.* (1980) reported the female longevity ranged from 9 to 20 days.

Bhattacharya *et al.* (1993) reported that and female longevity 4.5 days and 7.8 days respectively which were positively and significantly correlated with the four abiotic factors. But the present findings did not reveal any significant correlation between adult longevity and the abiotic factors. Kumar and Jolly (1986) reported that female longevity was negative and significant correlation with temperature but positive and non-significant correlation with humidity.

Female fertility

Fertility was found to be varied from 28.57% to 33.33% (Table 3 and 2) and positively correlated with all the four abiotic factors (Table 4). Bhattacharya *et al.* (1993) reported that fertility of the normal female flies varied from 41.07% to 86.7% (average 69.2%) and has positive correlation with maximum temperature and maximum humidity.

Fecundity

An average of 72 eggs (range 54 to 95) were laid by an adult female fly during 3 to 5 days of its life span.

Sriharan (1980) observed an average fecundity of a female uzifly to be 380 eggs. kumar and Jolly (1986) reported that an average of 448.50 eggs were laid by a female fly. In the present investigation it was observed that fecundity has no significant correlation with any of the abiotic factors. Bhattacharya *et al.* (1993) reported that there was a negative correlation between fecundity and minimum temperature at 5% level which is contradictory to the present finding.

Sex ratio

Sex ratio of adult was found to be ranged from 1:0.77 to 1:1.1. (male stands as one unit). Sriharan (1971) and Datta and Mukherjee (1978) reported that sex ratio was 1: 1 which was closer to the present observation.

Statistical correlation of the data indicated positive and significant correlation with all the four abiotic factors at 1% level. This is in confirmation with eh finding by Bhattacharya *et al.* (1993).

Generation survivability

Generation survivability varied from 4.44% to 7.04% (Table 3 and 1). Bhattacharya *et al.* (1993) observed that it varied from 7.9% to 52.08%.

Statistical correlation of the data indicated positive and significant correlation at 1% level with all the four abiotic factors. This is in confirmation with the results recorded by Bhattacharya *et al.* (1993). So, it appears from the study that both host (II stage silkworm larvae) and abiotic factors (temperature and humidity) play important roles on the life cycle of uzifly. The reasons for low biotic potentiality of uzifly, *E. bombycis* as revealed from the result of its parasitization on II stage silkworm larvae are discussed as follows.

High egg mortality was probably due to insufficient space at the intersegmental regions of young silkworm body on which eggs were laid and contraction and relaxation of skin during movement of the host disturbed the parasitoid eggs to hatch. The abiotic factors also attributed to it for high mortality.

High mortality of the parasitoid larvae and their enhanced developmental period were due to limited food and space inside the young age host body. According to Patil (1983), the maggot development depended on larval instar parasitized.

It was observed that the uzi larvae which died inside the body of the young silkworms also caused fatal to the host. Sengupta *et al.* (1980) observed that the uzifly infested V stage larvae in which the parasitoid larvae died before completion of their development, the host larvae were found to have survived and completed their life cycle. So, it appeared from the present investigation that the young silkworm larvae, if infested with uzifly, could not withstand the effects of parasitization even though the parasite died inside the host.

Slightly decreased maggot period might be due to its poor growth happened during the parasitic developmental stages inside the young age host larvae.

Emergence of week and smaller size of uziflies having shorter longevity was also due to smaller size of their host, which caused the parasitoid larvae under nourished. Similarly, low fertility and fecundity caused by poor development and shorter longevity of the flies. This is in well agreement with the views made by Kumar and Jolly (1986). During the course of the present studies it is revealed that if that host is a young silkworm larvae (II Instar) survival rate of uzifly at every stage of development and its multiplicity in the following generation is greatly reduced compared to the parasitization on the late stage silkworm larvae (V instar) Bhattacharya *et al.* (1993) and Narayanaswamy *et al.* (1993).

Nevertheless the parasitoid larva, if dies inside the host larva, causes death of the host which ultimately affects on cocoon production. So, serious care must be taken to prevent the entry of uziflies into rearing houses during chawki rearing.

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*Not seen the original.

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Short Communication

New records of some natural enemies of the teak defoliator, *Hyblaea puera* Cramer (Lepidoptera: Hyblaeidae) from Kerala, India

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Abstract: Six species of hymenopteran parasitoids viz., *Camptotypus arianus arianus* (Cam.), *Xanthopimpla* sp., *Theronia maskeliyae* (Cameron) (Ichneumonidae), *Psilochalcis carinigena* (Cameron), *Brachymeria lugubris* (Wlk) (Chalcididae) and *Tetrastichus howardi* (Oliff) (Eulophidae) and 4 species of reduviid predators viz., *Euagoras plagiatus Burmeister, Endochus* sp., *Rhenocoris fuscipes* (Fabricius) and *Sphedanolestus aterrimus* Distant were recorded for the first time from the teak defoliator, *Hyblaea puera* Cramer (Lepidoptera: Hyblaeidae). All the species were recorded from teak plantations in Kariem Muriem, Nilambur Forest Division, Kerala.

Keywords: Hymenoptera, Reduviidae, parasitoids, predators, teak defoliator, *Hyblaea puera*

INTRODUCTION

A wide variety of insects have been reported as parasitoids and predators of the teak defoliator *Hyblaea puera* (Lepidoptera: Hyblaeidae) (Stebbing, 1908; Beeson, 1934, 1941; Chatterjee and Misra, 1974; Sudheendrakumar, 1987). In connection with a study on the population dynamics of this insect, regular sampling of the immature stages was carried out during 1987 to 1989 from teak plantations at Kariem Muriem, Nilambur, Kerala. Larval and pupal parasitoids emerging from these samples were collected and identified by reference to experts. While some of these have been reported earlier some were new records. This included 6 species of Hymenoptera and 4 species of Heteroptera. The identity of these insects with brief notes on their habits is given below:

ORDER: HYMENOPTERA

Family: Ichneumonidae

1. Camptotypus arianus arianus (Cam)

This is an endoparasitoid attacking fourth and fifth instar larvae of *H. puera*. The larval period of the parasitoid completes by the time the host larva pupates. It then leaves the host pupa and pupates in a cocoon which is yellowish brown and measuring about 2 cm

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in length. Its occurrence is rather rare as we could collect it only once during August 1988.

2. Xanthopimpla sp.

This is a solitary pupal parasitoid. This parasitoid was recorded only once during the first week in August 1988. The percent incidence of this parasitoid was low and only one out of the 24 pupae collected was found to be parasitised.

3. Theronia maskeliyae (Cameron)

This pupal parasitoid was also rare and was recorded only once during the last week of September 1989. Only one out of the 869 pupae collected, was attacked by this parasitoid.

Family:Chalcididae

4. Psilochalcis carinigena (Cameron)

This pupal parasitoid which was recorded only once during the study period was collected during the last week of March 1989. Only one out of the 252 pupae collected was found parasitised by this species. This parasitoid is also known to parasitise *Opisina arenosella* Walker (Oecophoridae) - a serious pest of coconut which is widely distributed in the Indian subcontinent (Narendran, 1989).

5. Brachymeria lugubris (Wlk)

This is a solitary endoparasitoid attacking pupal stages. Out of 852 pupae collected during the last week of September 1989, only one pupa was found to be parasitised. It is also known to parasitise the *Ailanthus* defoliator *Atteva fabriciella* (Swederus) (Lepidoptera:Yponomeutidae).

Family : Eulophidae

6. Tetrastichus howardi (Oliff)

Out of the 252 pupae collected in April-May 1988 from leaf litter on the ground, two were found to be parasitised by this parasitoid. From each parasitised pupa, 9 parasitoid adults emerged.

ORDER:HETEROPTERA

Family:Reduviidae

Four species of reduviids were found predatory on the larval stages of *H. puera* in teak plantations at Kariem-Muriem as listed below:

1. Endochus sp.

Predatory on fourth instar larvae.

2. Euagoras plagiatus Burmeister

Predatory on third instar larvae.

3. Rhenocoris fuscipes *(Fabricius)*

Predatory on third instar larvae.

4. Sphedanolestus? aterrimus *Distant*
Predatory on third instar larvae.

CONCLUSION

Altogether about 52 species of natural enemies belonging to Hymenoptera (22 sp.), Diptera (16 sp.), Coleoptera (6 sp.), Dictyoptera (5 sp.) and Hemiptera (3 sp.) have been reported from *H. Puera* by various workers as indicated earlier. The insects recorded in this study are new records for *H. puera* in India.

ACKNOWLEDGEMENTS

The author is grateful to Dr. K. S. S. Nair (Scientist-in-Charge, Entomology Division) for his valuable guidance throughout the study period. Thanks are due to Dr. V. V. Sudheendrakumar and Dr. George Mathew (of this Institute) for critically going through the manuscript. Dr. G. M. Stonedahl, dr. J. LaSalle, Dr. I. M. White (I. I. E., London), and Dr. T. C. Narendran (University of Calicut, India) kindly identified the insects reported here.

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Short Communication

A new species of the genus *Callogryllus* (Orthoptera: Gryllidae) with remarks on its zoogeography

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Abstract: The author came across a new species, the twelveth species of the genus *Callogryllus* from the grylloid collections of Arunachal Pradesh, which is described here.

Keywords: New species, genus *Callogryllus* Arunachal Pradesh.

The genus *Callogryllus*, seems to have originally evolved in the tropical regions of India and Africa during Cretaceous period when there was land connection between the two land masses. The beginning of the discontinuous and relict distribution in India and Africa in the case of Gryllidae is not an independent happening and the discontinuity is secondary and of a recent origin from a former continuous distribution. This indicates that the present continents had suitable land connections for the dispersal of the various species (Hora, 1937). Such species in Africa, Peninsular India, N. E. India and Thailand during the course of evolution living in isolation for a long time have undergone some changes but still exhibit marked similarities in morphology, structure and behaviour.

There was a continuity of Vindhya–Satpura hills with Assam Himalayas in the North East on the one hand, and some regions of the Western Ghats on the other as indicated by the present ecological similarity between them. The intervening area was at one time a high forested belt, continuous with the two areas mentioned above, and provided the pathway of migration to the ancestral stock of the present species (Roonwal and Nath 1949). Of the eleven known species of the genus *Callogryllus* five are known from Tropical Africa, five from India (four from Tamil Nadu and Kerala and one from West Bengal) and one from Thailand. While examining the grylloid collections from Arunachal Pradesh, the author came across a new species, the twelveth species of this genus which is described and illustrated here.

***Callogryllus tengalis* n. sp.**

Male

Body small, colour light brown. Head with light bands on occiput. Eyes black, face, palpi pale, Pronotum with rather parallel margins, with bristles on disc, anterior and posterior edges, two brown bands along median line in posterior half; lateral lobes with

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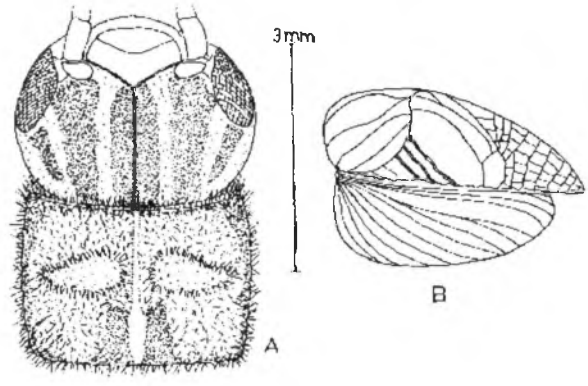

Figs. A–B. *Callogryllus tengalis* Sp. nov.; A. Head and Thorax B. Elytra of male

inferior margin slightly ascending posteriorly, inferior part a little lighter. Antennae filiform, pubescent, central part lighter. Legs light brown. Fore tibiae perforated with cylindrical tympana on both sides. Hind femora rather thick, pubescent, mottled with rufous, posterior tibiae armed with 5 spines on each superior margin.

Tegmina extending to apex of 5th abdominal tergite, a little rounded at apex; mirror reduced almost lost among the apical reticulation, 3 oblique parallel veins, lateral field lighter, with 5 regularly distant veins. Hind wings absent.

Measurements: Length, 12 mm, pronotum, 2 mm long; post femur 6 mm long; tegmen 4 mm. Holotype ♂India: Arunachal Pradesh, Tenga valle distt. W. Kameng, 24.9.84, Coll. R. N. Bhargava. (The type of the new taxa is deposited in the Desert Regional Station, Zoological Survey of India, Jodhpur).

REMARKS

C. tengalis differs from the known species of the genus in having somewhat larger tegmina reaching apex of 5th abdominal tergite; 3 oblique veins in the male tegmina and with light bands on the occiput. The genitalia will be studied when more specimens of this species are available as the holotype is delicate.

Key to the identification of species of *Callogryllus* of Chopard (1969) is modified below to accommodate the new species.

1. Head blackish above, without any pattern small (0.10 mm) forewing very short, extending only to the apex of first abdominal tergite ..... *curtipennis* Ch.
   Head provided with yellow bands or spot 2
2. Head adorned with light brown bands on occiput ..... *tengalis* n. sp.
   Head with a yellow band or a spot along the internal margin of eyes 3
3. Head chocolate-brown, with a yellow spot between the lateral ocelli and the eyes (size rather large 17 mm) ..... *gravelyi* (Chop.)
   Head blackish with a yellow band extending from the occiput along the eyes and antennal sockets to apex of the rostrum 4

4. Yellow bands of the head ending on the sides of rostrum 5
   Yellow bands of the head united by a transverse band at top of the frontal rostrum *ornaticeps* Chop.
5. Elytra of female very short, with strongly oblique internal margin . . . . *subopacus* (Bol.)
   Elytra of female extending at least to the apex of second abdominal tergite 6
6. Size rather large (0.14–16mm), elytra of female longer (3.5mm).*orientalis* (Bol.)
   Size smaller (0.12 mm); elytra of female shorter (2 mm) . . . . . *bilineatus* (Bol).

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Short Communication

Role of Kairomones in Host Selection by *Apanteles taragamae* Wilkinson, a larval Parasitoid of *Opisina arenosella* Walker

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Abstract: Successful oviposition by the parasitoid *Apanteles taragamae* (Braconidae: Hymenoptera) in the second instar naked larvae (without gallery of *Opisina arenosella* took place in 15.38% of cases, while in the larvae with their intact gallery the rate of oviposition reached upto 74%. When the second stage *Corcyra cephalonica* larvae were kept inside the second stage larval gallery of *O. arenosella*, 60% of them were successfully parasitised, while neither the naked larvae of *C. cephalonica* nor those with their own galleries were accepted by the parasitoid. When *O. arenosella* larvae were placed in *C. cephalonica* gallery and were provided to the adult parasitoid of *A. taragamae*, none of them were parasitised. It is therefore evident that certain chemical substances (Kairomones) emitted from the larval gallery of *O. arenosella* served as prime factor in host searching and oviposition behaviour of the parasitoid and by manipulating these kairomones it was possible to rear the parasitoids on alternate hosts.

Keywords: Kairomone, Oviposition, *Apanteles taragamae, Opisina arenosella, Corcyra cephalonica.*

Some of the braconid parasitoids are important biological control agents against a number of harmful pests of agriculture and forest plants. *Apanteles taragamae* Wilkinson is a common braconid parasitoid attacking the early larval stages of *Opisina arenosella* Walker, a serious pest of coconut. Biology of this parasitoid has been studied by workers like Rao *et al.* 1948; Nirula, 1956; and Ghosh and Abdurahiman, 1988, 1993. One of the problems in utilising this parasitoid in biocontrol programme is the difficulty experienced to rear it in the laboratory conditions (Nirula, 1956; Rao *et al.* 1948; Mohamed *et al.* 1982). In the present study we have concentrated on the possibility of its mass breeding on hosts other than its own, using the kairomones emitted by the frass of the II stage larvae of its true host *O. arenosella.*

A culture of *Apanteles taragamae* was maintained in the laboratory from the field collected cocoons. The adult parasitoid emerged from these cocoons were supplied with 50% honey as food. Laboratory reared II stage larave of *O. arenosella* were provided as host to maintain the culture. In order to study the effect of kairomones emitting from the frass, the fresh gallery made by the early instar larvae of the host were collected and the II stage larvae were placed beneath it. The percentage of successful oviposition was recorded. Similarly the percentage of parasitism in the naked larvae (without gallery) was also calculated.

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Table 1
Role of host larval frass in oviposition by *Apanteles taragamae*

Choice description	Total No. of hosts given	No. of larvae parasitised	% of successful oviposition
Free II instar *Opisina* larva without gallery	120	19	15.83
II instar *Opisina* larva with gallery	45	33	73.33
II instar *Corcyra* larva without gallery	60	00	00
II instar *Corcyra* larva with gallery	60	00	00
II instar *Corcyra* larva kept within II stage *Optsina* larval gallery	40	24	60
II instar *Opisina* larva in *Corcyra* gallery	40	00	00
II Instar *Spodoptera mauritia* in II instar *Opisina* gallery	10	00	00

The second instar larvae of *Corcyra cephalonica* reared in the laboratory were transferred to a petridish and were exposed to 10 mated female parasitoids of *A. taragamae*. A set of such larvae along with their gallery were kept in another petridish with 10 mated females of *A. taragamae*. In another set, the II stage larvae of *C. cephalonica* were placed in a gallery woven by the II stage larvae of *O. arenosella*. The percentage of parasitism in each case was noted.

These experimental larvae were reared in the laboratory to note the extent of successful development of the parasitoid in them. Dissections of the parasitised host larvae were also made in the laboratory to find out whether any host immune reaction took place towards the parasitoid egg.

Apanteles taragamae is a solitary endoparasitoid of *Opisina arenosella* with a limited host range. The parasitoid often preferred early stage larvae of *O. arenosella* for oviposition (Ghosh & Abdurahiman, 1985). *A. taragamae* prefers to lay eggs in host larvae concealed within the larval gallery to those of free moving ones. Successful oviposition by the parasitoid in the second instar naked larvae (without the gallery of *O. arenosella*) took place in only 15.83% of cases, whereas when kept intact with the gallery it reached as high as 73.3% (Table 1).

When the II instar *C. cephalonica* larvae (not the true host of *A. taragamae*) were placed in the gallery woven by second instar larvae of *O. arenosella*, the parasitoid readily oviposited in it. After oviposition the parasitoid often waits and examined the *C. cephalonica* larva with its antennae. Observations have indicated that some of the eggs laid in such host showed development. However, when the same experiment was tried

with *Spodoptera* larvae the parasitoid was reluctant to lay eggs.

When the second instar larvae of *C. cephalonica* without any larval gallery were provided, none of them were parasitised by *A. taragamae*. This was also the case with *C. cephalonica* which were retained with its own gallery. But when the same *C. cephalonica* larvae were kept within the gallery woven by the II instar *O. arenosella*, nearly 60% of them were parasitised, though further development did not take place in some of them. In an alternate experiment with *O. arenosella* larvae being kept inside the gallery of *C. cephalonica*, the parasitoid refused to accept the host. However, it was possible to rear *A. taragamae* in some other unnatural hosts (not of its own) using either the crude kairomones or the frass of the II instar *Opisina* larva. The parasitoid also oviposited in a species of bag worm when wrapped inside the II stage *O. arenosella* larval gallery.

The data therefore clearly substantiate the fact that some chemical substance present in the frass of the early instar larvae of *O. arenosella* induced a very strong host searching and oviposition behaviour in *A. taragamae*.

The larval mortality of the parasitoid was found to be minimum when developed in its normal host (*O. arenosella*), in which the development was successfully completed in 92.4% cases. The occurrence of larval mortality in unnatural hosts was also reported by Kawakami & Kainoh (1986). According to them, the parasitoid *Ascogaster reticulatus* Watanabe did not respond to the egg mass of the noctuid *Leucamia* (Methimna) *separata* unless it was coated with the kairomones of its original host. The first instar larva hatched in this 'host' was soon encapsulated.

In *A. taragamae* the chemical stimulus that originates from the larval frass/gallery served as a prime factor in host location. This is followed by mechanical stimulus (vibrating movement of the gallery caused by the escaping larva lying underneath the gallery, due to the probing of the parasitoid with its ovipositor to locate the host) and visual stimulus (movement of the gallery clearly indicates the position of the host underneath the gallery). It seems that certain chemical substances present within the integument of the host caterpillar are also involved in the final host selection in *A. taragamae*. Lee *et al.* (1989) showed a chemical extracted from the host pupal cuticle with ethanol that elicited oviposition behaviour in *Brachymeria lasus* Walker. The presence or absence of such attractant/repellent chemicals within the host integument may be the reason why they were reluctant to lay eggs in certain unnatural hosts, while in yet others (eg. the larvae of *C. cephalonica*, and in a species of bag worm, which were kept in a gallery woven by the second stage larvae of *Opisina arenosella*) they readily oviposited. Kainoh and Tatsuki (1988) are of the opinion that both external and internal kairomones are needed to elicit oviposition response in *Ascogaster reticulatus*, the external factor for host location and the internal for oviposition. According to them the activity of the latter is not specific as ovipositional activity was found in some other hosts like *Pieris rapae crucivora, Bombyx mori* and *Tenebrio molitor*.

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Short Communication

Denticera divisella Duponchel (Pyralidae: Lepidoptera) infesting *Euphorbia antisyphilitica* in the arid zones

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Euphorbia antisyphilitica Zucc (Syn *E. cerifera* Alocer), an exotic plant from Mexico, was introduced in the sixties at the Central Arid Zone Research institute, Jodhpur. The plant is a valued source of candelilla wax which finds application in medical and industrial fields.

Fig. 1. Depicting the damage of *Denticera divisella* to *Euphorbia antisyphilitica*

It is severely infested by an insect complex of Lepidopterous alliance. Singh and Vir (1989) reported *Homoeosoma* sp. to be one of the serious pests of this plant. Another insect, *Denticera divisella* Duponchel, a pyralid, was found to be associated with the former in skeletonization of *E. antisyphilitica* plants. Because of the activity of this insect the wax yielding portion of the plant is lost and the very purpose of raising the plants is defeated. The light to dark green coloured caterpillars feed independently or gregariously under the cover of a thin web often interspersed with faecal matter, exuviae etc. The larvae devour the outer green soft portion of the phylloclade (modified

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stem). The affected portion later dries up (Fig. 1). There is a large variation in extent of injury on different plants raised at the same location. There are several overlapping generations of the insect.

The insect was identified by Dr. J. D. Bradley of CAB International Institute of Entomology, London, whose services are gratefully acknowledged.

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Short Communication

Preparation of a Mechanical Aspirator–needs no inhalation

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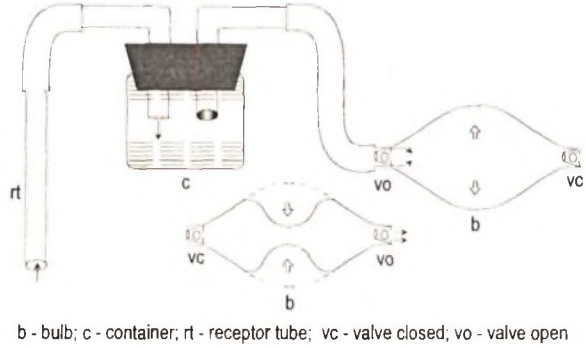
Abstract: A mechanical sucking device made up of a rubber bulb and valve systems, was used in an aspirator, to suck and catch the small flies to avoid aspiration in filthy habitat.

Keywords: Aspirator, Rubber bulb, Flies.

Small, active but tender and soft insects like leafhoppers, white flies, very small hemipterans and very delicate dipterans may easily be collected by a sucking tube or aspirator, without inflicting much damage to the insects. Use of such aspirator has been already mentioned (Srivastava, 1990; Ghosh 1990; Varshney, 1990 and Joseph, 1990). But use of this vary simple and easy apparatus also becomes difficult, when the tiny insects rest on very much dirty and filthy habitats like municipal sewerage, dust bins, vats etc; making the aspiration almost impossible. To overcome such a difficulty, the use of a mechanical sucking device was thought about. This would, not only prevent the unhealthy inhalation but also would add to the efficiency of the aspirator itself (Fig. 1).

A small transparent plastic container (5 cm. diameter) with wide mouth and tightly fitted with a relatively, larger block of cork was taken. Two long glass tubes bent at



b - bulb; c - container; rt - receptor tube; vc - valve closed; vo - valve open

Fig. 1. Digramatic Model of Mechanical Aspiration

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Table I
Showing no. of flies per catch

No. of catch	No. of flies	No. of damaged if any
Ist	28	1
2nd	24	0
3rd	23	0
4th	27	0
5th	28	1
6th	20	0
7th	21	0
8th	24	1

almost right angle in the middle, were tightly fitted, pushing through two small holes on the cork. One tube was extended near the bottom of the container, at one end, and the outer end was fitted with a rubber tube and a glass made receptor tube. The other glass tube was pushed through the cork of the container. The end was tied with a thin piece of net and was kept at the upper level, in the container. The outer end of the tube was fitted with a rubber tube, which in turn joined with a sucking device. The sucking device was prepared with a rubber bulb open at two ends almost like automiser bulb with only exception, that the two valve were arranged in opposite sequence at two ends. When the bulb was pressed with hand, the air was expelled through the posterior valve, without disturbing the container, which was connected to its anterior end. But when the bulb was relaxed, air always passed in, through the receptor tube, and the container. Thus if the receptor tube was approached against small insects, the insects could be captured with the inflowing aspiratory current into the container. A layer of cotton wool was put on the bottom of the container and another layer below the cork layer, to prevent the insects being damaged, due to the strikes against the walls of the container. All the fitting of the container were made air tight.

The efficiency of the aspirator was tested upon the small Diptera fly *Brachydentera longipes* Hendel, (Fam. Ephydridae); hundreds of which were resting upon the thin scum over a municipal sewage. Measurement of each fly was 2.5 mm. wide by 2.0 mm. long.

Five consecutive sections were given, pressing and relaxing the rubber bulb and approaching the receptor tube, close to the flies. This required only 2 minutes for the operation. The same operation was repeated 8 times at every five minutes interval. The number of flies of each catch (total of five sections) were counted.

The number of flies per catch are shown in the Table I.

The number of flies caught every time is very much significant. As the container part is made up of plastic and cork, the whole instrument remained very light and easy to handle.

The instrument proved to be very much effective and efficient to collect the small flies from all kinds of habitat. The same instrument may be used to transfer the flies or mosquitoes from one cage to another, in case of experiment with them.

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Short Communication

Effect of Microbial insecticides on the control of *Maruca testulalis* and on the predators of redgram pest complex

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Abstract: Effect of *Heliothis* nuclear polyhedrosis virus (HNPV), *Bacillus thuringiensis (B.t.)* and *Beauveria bassiana* (fungus) on the control of *Maruca testulalis* and on predators of pest complex was assessed during kharif 1992-93 on redgram at dry land farm and in the Department of Entomology, S.V. Agricultural College, Tirupati.

The treatments used for the control of *M. testulalis* were NPV 1×10^7 PIBS/ml, *B.t.* 1×10^7 spores/ml, *B. bassiana* 1×10^7 spores/ml, NPV + *B.t.* (1×10^7 PIBS/ml + 1×10^7 spores/ml), NPV + *B. bassiana*, *B.t.* + *B. bassiana*, monocrotophos 0.05%, Neemguard 1%, NPV (1×10^7 PIBS/ml) + monocrotophos 0.025%, *B.t.* + monocrotophos 0.025% and *B. bassiana* + monocrotophos (0.025%). The highest larval population reduction (53.18 per cent) was recorded with the treatment of *B.t.* + monocrotophos and the lowest reduction (9.23 and 8.78 per cent) were noticed in the treatments of *B. bassiana* alone and NPV + *B. bassiana* respectively (Table.1). No larval population reduction was observed in the treatment of NPV alone. These results are in agreement with the observations of Karel and Schoonhoven (1986) who reported that combined application of Carbaryl or Lindane with *B.t.* against the larvae of *Heliothis armigera* and *M. testulalis* recorded high dry seed yield in bean plants.

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Table 1
Efficacy of microbial pesticides along with chemical insecticides in the control of spotted pod borer, *Maruca testulalis*

Treatments	Percentage larval reduction days after treatment					
	2	7	14	21	25	Mean
1. NPV alone	0.00	0.00	0.00	0.00	0.00	0.00^{g}
2. *B.t.* alone	7.65	50.65	59.70	55.61	59.90	46.70^{bc}
3. *B. bassiana* alone	4.30	10.72	10.66	9.91	10.55	9.23^{f}
4. NPV + *B. t*	6.53	52.74	60.30	53.33	53.57	45.29^{c}
5. NPV + *B. bassiana*	3.93	9.55	9.32	10.65	10.43	8.78^{f}
6. *B. t.* + *B. bassiana*	9.71	53.62	58.70	62.72	62.90	49.53^{b}
7. Monocrotophos alone (0.05%)	10.00	35.31	50.00	52.31	50.63	39.65^{d}
8. Neemguard alone (0.05%)	9.60	29.64	27.31	32.92	32.97	26.49^{e}
9. NPV + monocrotophos (0.025%)	10.11	30.33	26.41	31.33	31.40	25.92^{e}
10. *B. t.* + mc crotophos (0.025%)	10.96	65.00	63.33	63.33	63.27	53.18^{a}
11. *B. bassiar* + monocrot os (0.025%)	9.34	28.63	25.00	29.00	29.99	24.39^{e}
12. Control	0.00	0.00	0.00	0.00	0.00	0.00^{g}
Mean	6.84^{c}	30.52^{b}	32.56^{a}	34.43^{a}	33.80^{a}	

All treatment of NPV, *B. t.* and *B. bassiana* carried 1×10^{7} PIBS/ml, 1×10^{7} spores/ml and 1×10^{7} spores/ml respectively.

	CD
Treatments	2.84
Days	1.84
Treatments × days	6.36

Values indicated by same letters are not significantly different

Table 2
Effect of NPV, *B. t.* and *B. bassiana* on predators of Redgram pests

Test insect	Number of adult predators taken	Mortality percentage due to HNPV	B.t.	*B. bassiana*
Menochilus sexmaculatus	60	–	–	10 (13.33)
Coccinella septum punctata	60	–	–	8 (10.66)
Rhinocoris fuscipes	60	–	–	5 (8.33)

Figures in parenthesis are percentage values

Heliothis armigera and aphids were treated with high concentrated HNPV (1×10^{9} PIBS/ml), *B.t.* and *B. bassiana* (1×10^{9} spores/ml) and fed to their predators viz., *Rhinocoris fuscipes, Menochilus sexmaculatus* and *Coccinella septumpunctata*. It was ob-

served that all predators were free of virus and *B.t.* but susceptible to *B. bassiana* (Table 2).

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Short Communication

Aonidiella orientalis (Newstead) (Diaspididae, Homoptera) and its natural enemies found on Sapota, Ber, Custard Apple and Banana

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Abstract: The oriental yellow scale *Aonidiella orientalis* (Newstead) was reported for the first time on Sapota. Natural enemies were collected on *A. orientalis* infesting custard apple and banana but they were inadequate to check the oriental scale.

Keywords: *Aonidiella orientalis*, natural enemies.

The oriental yellow scale *Aonidiella orientalis* (Newstead) (Homoptera: Diaspididae) is a polyphagous pest distributed in tropical and subtropical regions of th world (Williams and Watson, 1988). To search for its natural enemies, the scales were collected on fruit crops like ber (*Zizyphus mauritiana* L.) sapota (*Manilkara (=Achras) zapota* (Mill) Forberg), banana (*Musa* sp), and custard apple (*Anona squamosa* L.) *A. orientalis* was found on the leaves of banana, leaves, shoots and sometimes fruits of ber, custard apple and sapota. They suck the cell sap thereby reducing the vigour of the plants.

Persual of literature and also the review by Rajagopal and Krishnamoorthy (1996) revealed that the oriental yellow scale was known to infest over 30 species of plants in many countries. The record of *A. orientalis* on sapota (=Sapodillas) in the present study appeared to be new in India and elsewhere. Two years of survey conducted in Karnataka by Dhara Jothi and Tandon (1991) did not also indicate the presence of this oriental yellow scale on sapota. However, the scale had been reported on custard apple in Cuba (Mckenzie, 1946), *Zizyphus* spp and banana both in India and Pakistan (Butani, 1978; Ghani and Muzaffar, 1974).

In the present study, *Aphytis* sp was collected from *A. orientalis* infesting custard apple and banana but the parasitism did not exceed more than two per cent. Hayat (1986) had listed earlier 18 chalcid parasitoids known to attack *A. orientalis*. The scale was found preyed by the coccinellid *Scymnus* sp and the green lacewing *Mallada astur* (Banks) on banana but the former was more abundant than the latter. A fungal pathogen, *Clasdosporium* sp was also observed to infect *A. orientalis* on banana to the extent

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of 15–20 percent in February, 1995. No natural enemy was obtained from the scales collected on sapota and ber in the present study. According to Rajagopal and Krishnamoorthy (1996), the scale was known to be attacked by about 20 natural enemies in different countries, and they also indicated the potential of the parasitoid, *Comperiella bifaciata* How: and the predator *Chilocorus nigrita* (Fab.) which could be added to the present natural enemy complex for the suppression of *A. orientalis*.

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Short Communication

First record of *Ooencyrtus papilionis* Ashmead (Encyrtidae: Hymenoptera) on pomegranate butterfly *Deudorix isocrates* Fabr. (Lycaenidae: Lepidoptera)

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Abstract: The search for the natural enemies of pomegranate butterfly, *Deudorix (=Virachola) isocrates* (Fabr.) had revealed the presence of two egg parasitoids *Telenomus* sp. around Bangalore and *Ooencyrtus papilionis* Ashmead around Rahuri. *O. papilionis* is the first record on *D. isocrates* in India and elsewhere causing upto 70% parasitism during Aug-October '95.

Keywords: Pomegranate butterfly, *Deudorix isocrates*, egg parasitoid, *Ooencyrtus papilionis*, *Telenomus* sp.

About 45 insects were known to attack pomegranate (*Punica grantum* L.) in India (Butani, 1976). The lycaenid butterfly *Deudorix (=Virachola) isocrates* (Fabr.) has been reported as a major pest in many pomegranate growing hills and plains of India causing upto 65% loss of fruits (Zaka-ur-Rab, 1980; Nanjan and Kumar, 1983; Kabre and Moholkar, 1991). The management of this fruit borer was confined mainly with insecticides (Awate *et al.*, 1977; Shukla and Prasad, 1983; Kakar *et al.*, 1987). In order to develop a sound integrated pest management programme, a search was made for its natural enemies in Karnataka and Maharashtra in 1994-95. One to six eggs were found on the flower stalk and persistent calyx of the fruits. The plant parts with eggs were brought to the laboratory and kept in plastic jars to record the emergence of the parasitoids which were later sent to International Institute of Entomology, London for identification.

The present collections had revealed the presence of *Telenomus* sp. (Sceleonidae, Hymenoptera) in Karnataka and *Ooencyrtus papilionis* Ashmead (Encyrtidae, Hymenoptera) in Maharashtra. *Telenomus* sp. caused parasitism upto 7.0% around Bangalore while *O. papilionis* was known to parasitise the eggs upto 70.0% around Rahuri in August-October '95.

Though *D. isocrates* has been reported in Sri Lanka (Hutson, 1931) and about 10 states in India, not much information is available on the natural enemies of this pomegranate butterfly. Earlier about 15% egg parasitism by *Telenomus* sp. and an uniden-

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tified aphelinid was recorded on *D. isocrates* around Mysore (Hallepponavar, 1957). In the present study also, only low level parasitism was observed by *Telenomus* sp. around Bangalore. The another egg parasitoid *O. papilionis* was earlier recorded on the lepidopteran pests belonging to papilionidae, nymphalidae, danaidae, pyralidae, noctuidae, lymantriidae and sphingidae but not lycaenidae. Hence the present record of *O. papilionis* appeared to be the first on *D. isocrates* in India and elsewhere also. In India there was only one correct record of *O. papilionis* on *Papilio demoleus* (Linn.) by Jalali and Singh (1990). All other Indian records of *O. papilionis* from *Pyrilla perpusilla* Walker were erroneous and referred to *O. manii* (Huang and Noyes, 1994). Few larval parasitoids like *Brachymeria euploeae* Westw. (Narayanan, 1954), *Brachymerua nephantidis* Ghan (Narendran, 1989), *Apanteles* sp. n. *sauros* Nixon and *Charops obtusus* Morley (Shivale, Pers. Comm 1995) recorded on *D. isocrates* were of minor importance. Among the parasitoids recorded so far on this pomegranate butterfly only *O. papilionis* appeared to be more promising and now attempts are being made to develop a rearing technique for this parasitoid on some of the laboratory hosts.

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Short Communication

Correlation Study on Larval Silk Gland and Shell Weight in the Silkworm, *Bombyx mori* L.

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Abstract: The correlation of larval weight, silk gland weight and shell weight has been studied in a bivoltine silkworm *Bombyx mori* L. The larval weight was positively correlated with both silk gland weight and shell weight. Further silk gland weight was highly significant with shell weight.

Keywords: Larval, silk gland & shell weight, correlation, *B. mori*

The silkworm, *Bombyx mori* has been exploited by man as it produces silk. Sericulture industry has been revolutionised last two decades due to the research support in India. Much emphasis is being laid presently on production of superior quality of cocoons and silk to uplift the sericulture industry in India. In view of this Sericulture Bivoltine races of *B. mori* being known for their superior quality silk, hence, sericulture industry has exploited bivoltine races to produce the superior quality of cocoon and silk. Therefore, there is a need to standardise the techniques to get the quality cocoon resulting quality silk. Some correlations has been established on pupa and fecundity by Samachary & Krishnaswamy (1980), Gowda *et al.* (1988) Rithinam *et al.* (1991) & Afifa Shahen *et al.* (1992) in silkworm. However, literature on correlation on larval, silk gland and shell weight in bivoltine silkworms is scanty. Hence the present experiment was undertaken to determine the correlation of larval, silk gland and shell weight which may be more useful to improve the cocoon quality in *B. mori*.

50 mature larvae (6th day of V instar) of bivoltine race NB18 were selected randomly and weighted individually on digital electronic balance. 25 larvae of known weight dissected and taken out the complete silk gland and weight was recorded separately. Other 25 larvae (Approximately equal in weight of dissected larvae) were allowed to spun the cocoon in separate chambers of cocooning frames. After harvesting on 6th day of spinning, the cocoons were cut open and recorded the shell weight and pupa individually. The data were subjected to statistical analysis by using computer program to study the correlation of coefficients between:

(a) Larval weight and silk gland weight

(b) Larval weight and shell weight

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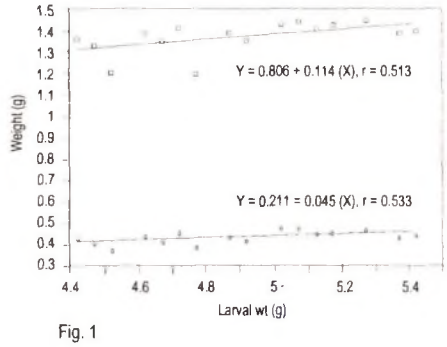

Fig. 1

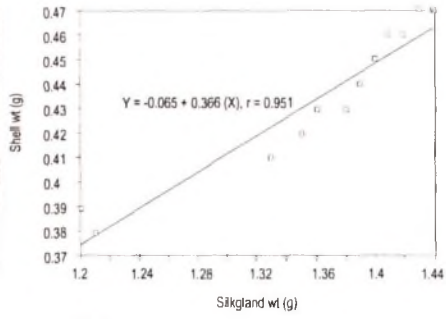

Fig. 2

Fig. 1. Regression of Y1 (silk gland wt.) and Y2 (shell wt.) on X1 (larval wt.); Fig. 2. Regression of Y2 (shell wt.) on X2 (silk gland wt.)

(c) Silk gland weight and shell weight

The mature larval weight was observed to know its relation with the silk gland and shell weight and results are presented in Table 1 and Figs. 1 and 2. The larval weight was positively correlated with both silk gland weight (r = 0.513) and shell weight (r-=0.533). However, The silk gland weight have shown a highly significant correlation with shell weight. Since relationship of larval weight with silk gland and shell weight was significant, regression equations of silk gland (Y1), shell weight (Y2), larval weight (X1), shell weight (Y2) and silk gland weight (X2), were obtained. After getting estimated values of Y1, Y2 and Y3 at different values of X1 and X2 linear regression lines were obtained by plotting graphs (Figs. 1 & 2). The results are similar to the earlier investigation of Samachary & Krishnaswamy (1980).

Table 1
Correlation of larval, silkgland and shell weight in *B. mori*

Mean of 25 observations						Correlation of coefficient between					
Lwt	Sgwt	Shwt	Sgwt/Lwt	Shwt/Lwt	Shwt/Sgwt	Lwt	Sgwt	Lwt	Shwt	Sgwt	Shwt
4.901	1.368	0.436	1.368/4.901	0.436/4.901	0.436/1.368		0.513		0.533		0.951
+0.077	+0.017	+0.006									

Lwt = Larval weight; Sgwt = Silk gland weight; Shwt = Shell weight.

A mean larval weight of 4.901 ± 0.007 g. possesses 1.368±0.017 g. of silk gland weight. The silk gland weight produced 0.436± 0.029 g. of shell weight. It was also found that silk gland shares 27.91% of larval weight and 31.87% of silk gland weight was transformed into shell weight. Further a highly significant correlation of larval weight with shell weight showed that the quality of cocoon possessing more silk contents.

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Short Communication

Notes on the Host range of *Goniozus nephantidis* (Hymenoptera: Bethylidae) with a new report on *Anigraea albomaculata* (Lepidoptera: Noctuidae) as an alternate host

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Abstract: *Corcyra cephalonica* Staint. is the only known alternate host of *Goniozus nephantidis* Mues., the biocontrol agent of the coconut pest, *Opisina arenosella* Walker. The host acceptance of *G. nephantidis* was tested in the laboratory by providing larvae of 26 species of lepidopterans. While the larvae of *Anigraea albomaculata, Herculia nigrivitta, Atteva fabriciella, Lamida moncusalis* and some others were paralysed, eggs were laid on all except *H. nigrivitta* and the development was completed only on *A. albomaculata.* This is a new report of an alternate host of *G. nephantidis.*

Keywords: *Goniozus nephantidis, Anigraea albomaculata, Opisina arenosella,* Biological control, Host range, alternate host.

Goniozus nephantidis Mues. (Hymenoptera: Bethylidae) is one of the most important larval parasitoids of the coconut pest, *Opisina arenosella* Walker (Lepidoptera: Aecophoridae) and it is extensively used as a biological control agent of the pest in nature. Though this parasitoid appears monophagous and host specific in the natural conditions, few lepidopteran larvae belonging to other families are also very well accepted for the completion of its life cycle. *G. nephantidis* was first collected from the host *O. arenosella* (Rao and Cherian, 1928). Dharmaraju (1952) reported *Corcyra cephalonica* Staint. (Lepidoptera: Pyralidae) as the alternate host which can be used for the laboratory rearing of this parasitoid. Here we report *Anigraea albomaculata* Hamps. (Lepidoptera: Noctuidae) a pest of cashew, as another new alternate host of *G. nephantidis* on which the life cycle is successfully completed.

The culture of *G. nephantidis* was maintained in the laboratory in clean specimen tubes closed with cotton plugs and provided with 50% honey solution and hosts for parasitisation. The host acceptability was tested by providing the larvae into the tubes

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with 4-6 day old, mated females. From the studies conducted in the laboratory with as many as 26 species belonging to different Lepidopteran families like Pyralidae, Noctuidae, Nymphalidae, Arctiidae, Saturnidae etc., it has been understood that the host range is very narrow even in artificial conditions. None of the Coleopteran larvae tried were accepted by the parasite. Out of the many hosts tried, *A. albomaculata, Herculia nigrivitta, Atteva fabriciella, Lamida moncusalis* and few unidentified larvae were successfully paralysed. On all these, except *H. nigrivitta*, the eggs were also found laid. Unlike the other hosts, *L. moncusalis* was quietened only after many stings. While the development was completed in *A. albomaculata*, only partial development was observed in the others. The subdued larvae of *L. moncusalis* got dehydrated and died within 1-4 days. Consequently the parasitoids could not complete their development on them.

The life cycle of the parasite on *A. albomaculata* was just as on *O. arenosella*, the females taking 11-14 days and male 10-12.5 days. The habits and habitats of *A. albomaculata* are also like that of *O. arenosella*. It makes galleries of silk and frass on the cashew nut tree leaves. The body dimensions and surface texture are also akin to the coconut pest. The presence of the parasite in the galleries of *A. albomaculata* on cashew nut trees in the field was also observed. This points to the occurrence of this parasite in the natural conditions.

Members of the family Bethylidae use larvae of Lepidoptera and Coleoptera as their hosts. The parasites belonging to Bethylidae including *Goniozus* are ectoparasitoids of microlepidopteran larvae. There are reports of them being parasitic on larvae of Pyraustidae, Gelechidae, Noctuidae, Pyralidae etc., (Gordh and Evans, 1976). Many species of *Goniozus* show polyphagous habits. *G. indicus* has host records on *Chilo partellus, C. infuscatellus, O. Sacchariphagus, Scirpophaga rhodoproctalis, S. nivella, Diatraea saccharalis, D. venosata* and *Proceras indicus* (Kurian, 1955). *G. japonicus* is a parasite of 20 species of lepidopteran larvae belonging to many families (Kishitani, 1961; Iwata, 1963). The present study shows that *G. nephantidis* is also polyphagous. Its prevalence on other hosts in natural conditions is yet to be verified. Though host specificity is very much appreciated in the case of a control agent, the suitability of other hosts for successful development is of survival value. Here as the reported alternate host is a potential pest of a cash crop, cashew, the importance of this parasitoid becomes still elevated.

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Short Communication

First Record of the Entomogenous Fungus *Zoophthora radicans* (Brefeld) Batko on the Rice Leaf Folder *Cnaphalocrosis medinalis* Guenee from India

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Abstract: The entomophthoralean fungus *Zoophthora radicans* has been recorded for the first time from India on Rice Leaf Folder *Cnaphalocrosis medinalis*.

Keywords: First record, *Zoophthora radicans*, *Cnaphalocrosis medinalis*

During the course of an extensive field investigations of microbial diseases of rice pests in the wet season of 1994-95, a majority of leaf folder *Cnaphalocrosis medinalis* (Guenee) larvae were observed to be killed by an entomogenous fungus in the rice fields of the Experimental Research Farm, Madur, Karaikal Region, Pondicherry Union Territory, India. The cadavers were anchored to the tip of uninfested rice leaves of copious cream-white fluffy fungal outgrowths sprouted from the cuticle. The fungus from naturally colonized larvae was identified as *Zoophthora radicans* (Brefeld) Batko (Zygomycetes: Entomophthorales) by the United States Department of Agriculture (USDA), Agricultural Research Service (ARS), Ithaca, New York and has been deposited in the ARSEF herbarium.

In the rice ecosystem, the infection of the fungus was first noticed during early November, 1994 coinciding with the peak larval emergence. The fungus remained rampant enough to kill the emerging population of Leaf folder larvae till the end of February, 1995. However, from the beginning of March when weather was dry larval mortality declined and almost negligible during summer months. The mycosis was favoured by high relative humidity (89%) accompanied by average rainfall of 127 mm and temperature between 20.7°C and 29.7°C prevailing during its occurrence.

Estimates of the incidence of mortality to the host larvae revealed the occurrence of 83% mycosis with a range of 11-97 per cent. However, the natural enemies of rice pests viz., coccinellids, ground beetles, spiders, wasps were not affected by the fungus under natural condition.

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The entomophthoralean fungus *Zoophthora radicans* has been reported to be pathogenic to diamondback moth *Plutella xylostella* (Ooi, 1981 and Pell *et al.*, 1992) and *Therioaphis trifoli* (Milner, 1982). Riethmacher *et al.*, (1992) from the philippines reported the natural epizootics of *Z. radicans* on the diamondback moth populations. The present report constitutes the first recorded account on the natural occurrence of *Z. radicans* on rice leaf folder population from India.

ACKNOWLEDGEMENT

The author wishes to express sincere gratitude to Dr. Richard A. Humber, Insect Mycologist, Plant protection Research Unit USDA - ARS, Ithaca, New York for confirming the identity of the fungal pathogen. He is also thankful to Mr. K. Kumaran, Agricultural Officer, Karaikal, for his assistance in carrying out the investigations.

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Short Communication

A New Species And A New Record Of Aphids (Homoptera: Aphididae) From Garhwal Range of Western Himalaya, India

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Abstract: This paper embodies the description of a new species *Cryptaphis salviae* infesting *Salvia leucantha* and one species *Schoutedenia emblica* (Patel and Kulkarni) records as new to the Garhwal range of Western Himalaya, India.

Keywords: aphids, taxonomy, new species, new record, Garhwal Himalaya, India

Cryptaphis Hille Ris Lambers is a very distinct genus with about seven species known from the World (Eastop and Hille Ris Lambers, 1976). So far only two species viz. *Cryptaphis rostrata* Chakrabarti and Raychaudhuri (1974) and *C. garhwalensis* Bhattacharya, Mandal and Chakrabarti (1983) are known from India. Among these two species, *Rostrata* is known from Himachal Pradesh (North West Himalaya) and *Garhwalensis* is known from Uttar Pradesh (Garhwal range of Western Himalaya). A new species *C. salviae* infesting *Salvia leucantha* in Uttar Pradesh (Garhwal range of Western Himalaya). is described here.

Except *salviae* all the Indian species are known from apterous viviparous morph. Hence a key is given for apterous viviparous females only.

Key to the Indian species of *Cryptaphis* (Apterous viviparous female)

1. Head without spinules; abdominal tergite 8 with 8 hairs; u. r. s. with 5 pairs of secondary hairs; cauda with 5 hairs .... *garhwalensis* Bhattacharya, Mandal and Chakrabarti.
   —Head with spinules; abdominal tergite 8 with 4–5 hairs 2
2. Antennal segment III without secondary rhinaria; cauda with 6 hairs; siphunculi 0.93–0.97 times as long as body; p. t. 0.66–0.69 times as long as antennal segment III ..... *salviae* sp. nov.
   —Antennal segment III with 2–4 secondary rhinaria; cauda with 4 hairs; siphunculi 0.10–0. 13 times as long as body; p. t. 1.08–1. 32 times as long as antennal segment III ..... *rostrata* Chakrabarti & Raychaudhuri.

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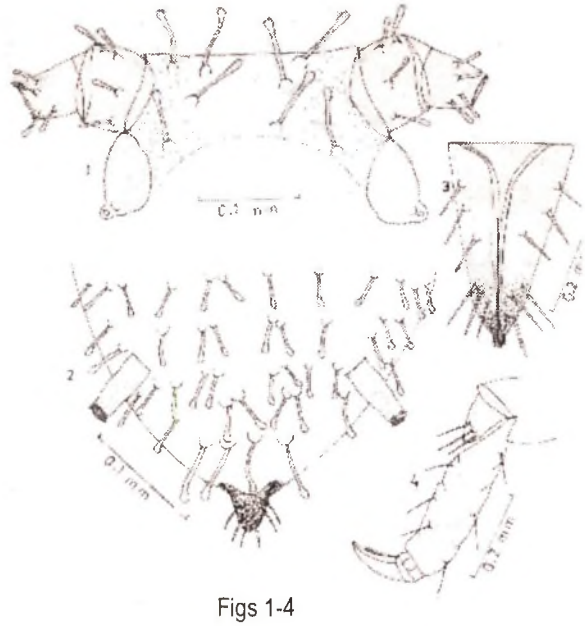
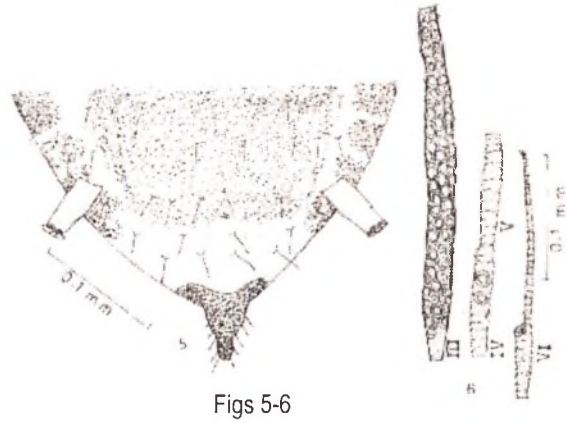


Figs 1-4



Figs 5-6

Apterous viviparous female: Fig. 1. Head; Fig. 2. Posterior part of abdomen; Fig. 3. Ultimate rostral segment; Fig. 4. Second joint of hind tarsus.
Apterous viviparous male: Fig. 5. Posterior part of abdomen; Fig. 6. Antennal segments III-IV.

Cryptaphis salviae sp. nov. (Figs 1–6) Apterous viviparous female (Figs. 1–4): Body 1.43–1.49 mm long with 0.58–0.65 mm as maximum width. Head pale brown with very poorly developed lateral frontal tubercles, sparsely spinulose both dorsally and ventrally, but such spinulosity is absent from a broad median area; frons with 4 pairs of long and stout hairs with capitate apices arise from distinct tuberculate bases; longest one on vertex about 0.068–0.071 mm long and 3.33–3.50 times as long as basal diameter of antennal segment III. Antennae pale, little darker apically about 0.79–0.85 times as long as body; segment III nearly smooth, abruptly constricted near the apex and then again swollen, rest of the flagellum gradually and distinctly imbricated apicad; hairs on the flagellum thick, distinctly arises from raised bases; segment I and II each with 4 hairs; segment III with 12–13 hairs, longest one about 0.023–0.027 mm long and about 1.16–1.33 times as long as basal diameter of the segment; processes terminalis about 2.55–2.66 times as long as base of the segment VI; segment III without secondary rhinaria. Rostrum reaches beyond mid-coxae, ultimate rostral segment about 1.07–1.14 times as long as second joint of hind tarsus with 3 pairs of secondary haris. Thorax pale brown, with few rows of spinules ventrally, mid-thoracic furca with separate arms. Abdomen pale brown, membranous; dorsal hairs long, stout with expanded to capitate apices, arising from distinct tuberculate bases; anterior tergites with 10–12 hairs, longest one about 0.061–0.064 mm long and 3.00–3.16 as long as basal diameter of antennal segment III; tergites 7 and 8 with 6 and 4 hairs, longest one on these tergites about 3.50–3.66 and 4.00–4.16 times as long as basal diameter of antennal segment III, respectively. Venter with rows of spinules; ventral hairs shorter, thinner than dorsal hairs and with acuminate to blunt apices. Siphunculi subcylindrical, pale brown, nearly smooth or faintly imbrecated with 1–2 rows of striae near the apex and with a distinct flange. Cauda tongue shaped with 6 hairs. Subgenital plate with 4 hairs on anterior margin and 10–12 hairs on posterior margin. Legs pale brown, femora smooth; femoral hairs with slightly to distinctly swollen apices; tarsi brown, imbricated, first tarsal chaetotaxy 3, 3, 3.

Measurements of holotype in mm: Body length 1.49, width 0.65; antenna 0.83, antennal segments III: IV: V: VI: 0.13: 0.13: (0.06–0.16); ultimate rostral segment 0.10; second joint of hind tarsus 0.09; siphunculus 0.15; cauda 0.10.

Alate viviparous female (Figs. 5–6): Body 1.82–1.84 mm long with 0.71–0.75 mm as its maximum width; Head dark, dorsal cephalic hairs short with acute apices, longest hair on dorsum about 0.015–0.17 mm long and 0.75–0.83 times as long as basal diameter of antennal segment III. Antennae brown about 0.74–0.78 times as long as body; processus terminalis about 2.33–2.62 times as long as base of segment VI; flagellar hairs short with acute apices; longest one on segment III about 0.011–0.013 mm long and 0.58–0.66 times as long as basal diameter of antennal segment III segment III with 67–71 IV with 2 round secondary rhinaria. Thorax black. Abdomen pale, tergites 3–6 with marginal scleritis, 3 with spinopleural bar, such spinopleural bars on tergites 4–6 confluent together to form a compact central mass; dorsal hairs short with acute apices, anterior tergites with 8–10 hairs, longest one about 0.017–0.018 mm long and 0.83–0.91 times as long as basal diameter of antennal segment III; tergites 7 with 4 hairs. Cauda with a constriction, little bulbous anteriorly and narrowed posteriorly, with 10–12 hairs. Media of the forewing twice branched, hind wings with both the obliques. Other characters as in apterous viviparous females.

Measurements of one specimen in mm: Body length 1.82, width 0.71; antenna 1.45, antennal segments III: IV: V: VI: 0.67: 0.20: 0.18: (0.11–0.27); ultimate rostral segment 0.09; second joint of hind tarsus 0.08; siphun culus 0.17; cauda 0.11.

Holotype: apterous viviparous ♀, India: Uttar Pradesh: Barunghati (Garhwal Himalaya), 15. IX. 1993 from *Salvia leucantha* (Collector, S. R. Dey). Paratypes: 6 apterous viviparous ♀♀, 3 alate viviparous ♀♀ and nymphs, collection data as in holotype.

REMARKS

Among *Cryptaphis* species infesting plants of Labiatae, this new species shows its closest resemblances with *Cryptaphis rostrata* Chakrabarti & Raychaudhuri (in Chakrabarti, Ghosh & Raychaudhuri, 1974). However, it can be separated from *rostrata* by shorter ratio of processus terminalis to the base of last antennal segment (3.10–3.60) in *rostrata*), shorter ratio of ultimate rostral segment to second joint of hind tarsus with 6 secondary hairs (1.60–1.70 times and with 4 hairs in *rostrata*) and apterous viviparous females without secondary rhinaria.

This species, can also be distinguished from *Cryptaphis menthae* Takahashi (in Takahashi, 1961) in having following combination of characters; first tarsal chactotaxy 3, 3, 3(3, 3, 2 in *menthae*), anterior tergites with 10–12 hairs (20 in *menthae*) and antennal segment III and IV with 67–71 and 2 secondary rhinaria in alate viviparous female (20 and 5–6 in *menthae*).

Schoutedenia emblica (Patel & Kulkarni)

Cerciaphis emblica Patel & Kulkarni, 1953 *J. Bombay Nat. Hist. Soc.* **51**: 435–38.

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Material studied

10 apterous viviparous ♀♀and nymphs. India: Uttar Pradesh: Gyansu (Garhwal Himalaya), **12**. VI. 1994 Frm Spirea sp. Collector, S. R. Dey).

Distribution

India: Andhra Pradesh, Maharashtra, Meghalaya, Tripura, West Bengal, Nepal.

REMARKS

This species is recorded for the first time from Garhwal range of Western Himalaya, India.

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Short Communication

Evaluation of some plant Extracts as feeding deterrents against adult *Longitarsus nigripennis* Mots (Coleoptera: Chrysomelidae)

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Abstract: Hexane extract of leaf and chloroform extract of seed of *Annona squamosa* showed high feeding deterrence against *Longitarsus nigripennis* Mots. When tested along with several plant extracts.

Keywords: *Longitarsus nigripennis, Annona squamosa*, feeding deterrent.

Conventional synthetic organic pesticides are handicapped in the environmental context by their long term persistence, high toxicity and propensity for bioaccumulation. In recent years increasing research has focussed on plant-derived insect antifeedants which are non-pollutant, generally less toxic and easily biodegradable especially if used as total or enriched extratives. Active constituents from plants possessing antifeedant activity have been isolated (Numata et al., 1990). In the present paper, we report the results of our studies on the antifeedant property of some plant extracts against the adult of 'Pollu' beetle *Longitarsus nigripennis* Mots. The beetle damaging tender shoots, leaves, spikes and tender berries is the most destructive pest on black pepper, the dried mature berries of *Piper nigrum* L. (Piperaceae) in India causing severe loss in yield (Devasahayam et al., 1988).

Different parts of plants listed in table 1 were shade-dried, powdered and extracted at room temperature using different solvents. In case of *Annona squamosa* (Custard apple) leaves, seeds and pericarps were extracted with hexane for 5 days and each junk was reextracted successively with chloroform and methanol in a rotary vacuum evaporator under reduced pressure and the residue were subjected to bioassay (Fig.1).

The adults of 'pollu' were collected from the field and the colony was maintained at 27±2 °C temperature and RH 70-90%. No-choice bioassay was carried out to test the feeding deterrence. Tender pepper leaf disks were cut (20 mm diameter) with a cork bore. The disks which were dipped in crude extracts containing acetone for one or two seconds were anchored after dryness in upright position to moist sponge kept

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Table 1
Antifeedant activity of plant extracts against *Longitarsus nigripennis* Mots adult

Plant material	Plant part	Solvent	Food consumption (mg/beetle/day)				Feeding ratio (%)		Inhibitory activity index	
			Conc(ppm)	5000(a)	2500(b)		(a)	(b)	(a)	(b)
Piper longum	Leaf	Hexane	8.01±0.21	(9.62±0.64)	9.12±0.47	(11.32±0.55)	83.26	80.56		
Piper colubrinum	Stem	Hexane	9.36±0.17	(10.84±0.82)	8.44±0.61	(9.92±0.84)	86.34	85.08	–	–
	Leaf	Chloroform	7.83±1.07	(9.11±0.19)	8.64±0.92	(9.48±0.92)	85.09	91.14	–	–
Piper accenuacum	Berry	Hexane	8.59±0.65	(10.21±0.78)	6.44±1.31	(8.36±0.88)	84.13	77.03	–	–
	Berry	Chloroform	6.48±0.72	(8.24±0.41)	8.37±0.85	(9.80±0.94)	78.64	85.41	–	–
Piper becel	Leaf	Hexane	8.40±1.03	(10.14±0.72)	6.66±0.36	(8.24±0.22)	82.84	80.82	–	–
	Leaf	Chloroform	7.28±0.67	(9.24±0.17)	7.62±0.57	(8.89+0.38)	78.79	85.79	–	–
Piper cubaba	Berry	Hexane	6.46±0.75	(8.21±0.82)	7.14±1.08	(9.27±0.63)	78.68	77.00	–	–
	Berry	Chloroform	8.45±0.54	(9.24±0.76)	8.11±0.38	(9.79±0.27)	91.45	82.34	–	–
Annona squamosa	Leaf	Hexane	2.54±0.74*	(9.27±0.36)	3.84±0.84*	(10.88±0.74)	27.40	35.29	+	+
	Leaf	Chloroform	6.32±0.51	(9.78±0.62)	7.19±0.80	(10.24±0.33)	64.62	70.21	–	–
	Leaf	Methanol	5.61±0.81	(8.22±0.24)	6.66±0.35	(8.97±0.87)	63.33	74.24	–	–
	Pericarp	Hexane	6.74±1.08	(8.33±0.56)	8.73±1.81	(9.81±0.64)	80.91	89.00	–	–
	Pericarp	Chloroform	7.47±0.62	(8.85±0.61)	6.35±0.89	(8.27±0.77)	84.40	76.78	–	–
	Pericarp	Methanol	6.27±0.56	(8.47±0.69)	7.33±0.51	(8.96±0.55)	74.02	81.80	–	–
	Seed	Hexane	7.44±0.77	(9.27±0.53)	7.88±0.61	(8.91+0.73)	80.43	83.44	–	–
	Seed	Chloroform	1.01±0.87*	(9.06±1.21)	1.82±0.65*	(8.26±0.43)	10.67	22.03	)	+
	Seed	Methanol	8.17±0.27	(9.83±0.57)	7.88±0.80	(9.24±0.96)	83.11	85.28	–	–

$$\text{Feeding ratio(FR)} = \frac{\text{Wt. of leaf consumed by beetle on treated leaf}}{\text{Wt. of leaf consumed by bettle on control leaf}} \times 100(\%)$$

Inhibitory Activity Index (IAI) ++ : Strong 0-20% of FR;
+ : Slight 20.1–50% of FR
– : None > 50% of FR

Value of mean ±SE of 10 beetles in each experiment
Control values are given in parentheses
*Means are significantly different (by t-test) at a significance level of 1%

inside the plastic bottles (6.5 × 4 cm) by small map pins. One beetle was introduced in each bottle. The mouth of the bottle was closed with cloth to prevent the escape of the beetles which were allowed to feed for 48 hrs after being starved for 4 hrs. Experiment and control bottles were placed simultaneously for each test in clean acrylic boxes (30 cm × 30 cm×30cm) in which a moist towelling was kept so as to get an uniform atmosphere when the boxes were closed with it's lid. Two different concentrations of the extracts were tested. Controls were treated with acetone alone. Each experiment was replicated four times.

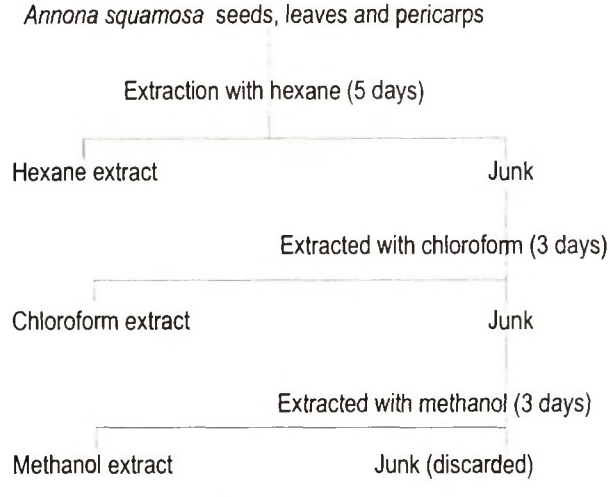

Fig. 1. Schematic presentation of *Annona squamosa* seeds, leaves and pericarp extraction

Food consumption was determined by weighing the oven-dried (24 hrs at 110°C) remains of leaf disks from each bottle to the nearest 0.01 mg (Mendel et al., 1991). Initial weights were determined by drying 100 additional leaf disks. Mean weights for these blank disks were assumed to be initial weights of the assay disks. Calculations of the amount of treated or control leaf consumed were made by subtracting the weight of the remains from the initial weight for the appropriate test. The feeding ration (FR) was measured and the inhibitory activity index (IAI) was evaluated (Lu & Chu, 1992).

The food consumption of the beetle is summarized in table-1. Both hexane extract of leaf and chloroform extract of seed of *Annona squamosa* showed effective antifeedant activity against *Longitarsus nigripennis* and the inhibitory activity index was strong

in chloroform extract at 5000 ppm. Insecticidal activity of seed extract of *A. squamosa* has been reported on a variety of insects (Saito et al., 1989). The seeds of this plant yielded two compounds–annonin and neoannonin which showed toxic effect to eggs, larvae and adults of *Drosophila melanogaster* (Kawazu et al., 1989). Power of seeds of custard apple was most effective against *Sitophilus oryzae* (Mishra et al., 1992) with regard to percentage damaged grain, percentage grain weight loss and average adult population and showed antifeedant effect at 0.05 and 0.1 gm against *Anthrenus vorax* (Shafeen & Dhawan, 1991). The preliminary efficacy test described here indicates a potential use of this plant in pest management system against *L. nigripennis*.

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Short Communication

Discovery of the Coccinellid Predator *Chilocorus circumdatus* on the Green scale *Coccus viridis*

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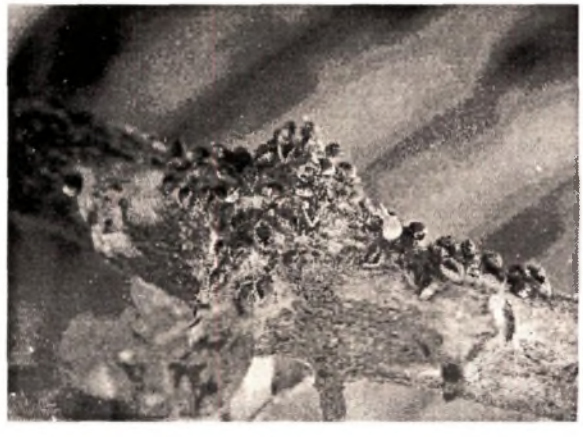
Abstract: The coccinellid *Chilocorus circumdatus* Sch. was discovered for the first time in large number preying on the green scale *Coccus viridis* (Green) infesting acid in 1994 around Bangalore. The predation lime by *C. circumdatus* along with *Chilocorus nigrita* (F.) had resulted in the effective suppression of the scale population on acid lime.

Keywords: Green scale, *Coccus viridis*, *Chilocorus circumdatus*, predator, citrus.

The green scale *Coccus viridis* (Green) (Homoptera: Coccidae) is known to cause severe damage to citrus and coffee plants in South India (Easwaramoorthy and Jayaraj, 1976; Singh and Rao, 1977). Heavy infestation of the green scale was observed in June, 1994 on acidlime, *Citrus aurantifolia* Swingle at Indian Institute of Horticultural Research Farm, Bangalore. The scale insect is a difficult pest to get controlled with insecticides. During the course of investigation to develop an effective biological control programme, *Chilocorus circumdatus* Sch. (Coleoptera, Coccinellidae) was found preying in large numbers for the first time on green scale infesting acidlime.



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Perusal of literature had revealed that *C. viridis* was known to be preyed by several coccinellids including eight species of *Chilocorus*. However heavy predation by *C. circumdatus* has not been reported earlier on the green scale in India and elsewhere. In the present study, all the stages of the predator were observed on the acidlime plants infested with scales. Higher population of the predator (upto 160 per plant) was observed in June-July coinciding with peak incidence of the green scale. After feeding the scale, the predatory larvae had congregated either under the leaves or on the tree trunk for pupation (Fig.1). A mean population of 240 scales observed per plant (4 shoots of 15 cm) in June '94 was brought down to 12 in September '94 mainly due to the activity of *C. circumdatus* along with yet another coccinellid *Chilocorus nigrita* (F.) Though *C. circumdatus* had not been reported on *Coccus viridis*, it was known to feed the other scales like *Chrysomphalus ficus* Ashm. (Das, 1979), *Aonidiella aurantii* (Maskell) (Rao and Debach, 1969) and *Quadraspidiotus perniciposus* (Comstock) (Wilson, 1960). The present report suggests that *C. circumdatus* has a great potential that could be exploited for the suppression of the green scale.

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Regionl Medical Centre (ICMR), Port Blair will be organising a National Symposium-cum-Workshop on Leptospirosis during 11-13 September 1997 at Port Blair, A & N Islands. The members who are interested to participate and present papers may provisionally register their names at the earliest. Correspondence in this regard can be made either to Professor S. C. Sehgal, Chairman, Organising Committee or Dr. V. G. Rao, Organising Secretary, Regional Medical Research Centre (ICMR), Prot Blair 744101, Andaman and Nicobar Islands.

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